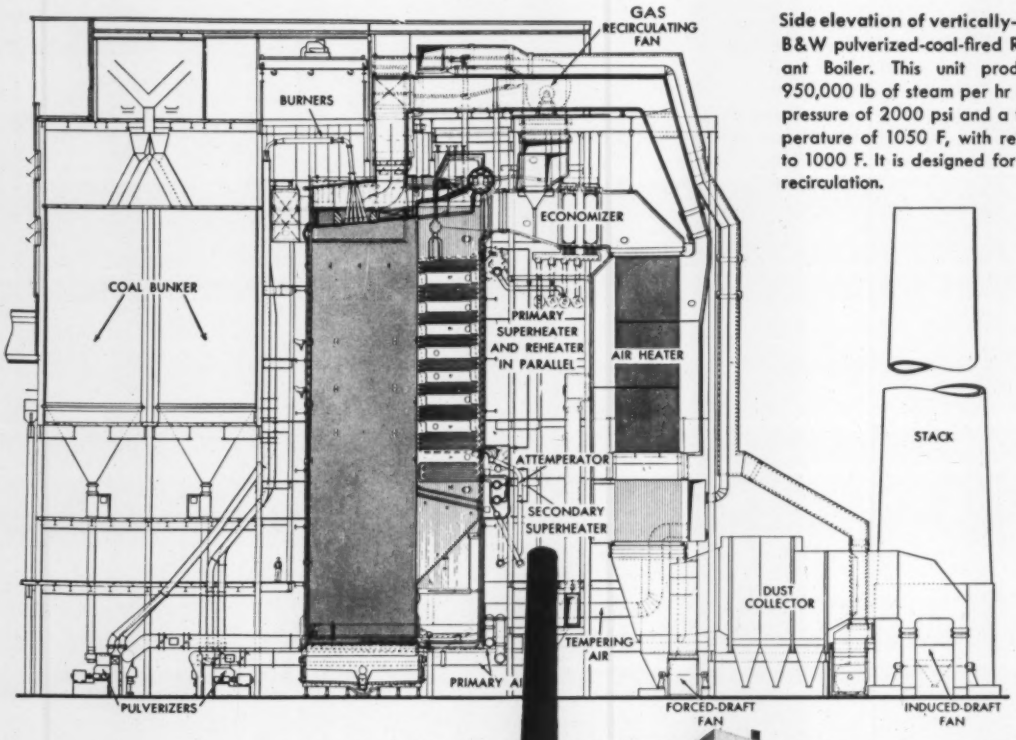
# MECHANICAL ENGINEERING

July 1956

in this issue

ASME Fall Meeting • Denver, Colorado • September 10-13, 1956

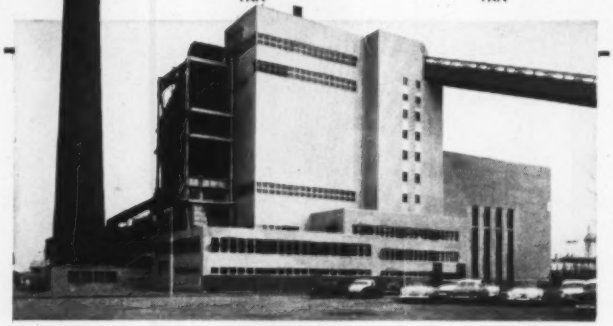



Side elevation of vertically-fired B&W pulverized-coal-fired Radiant Boiler. This unit produces 950,000 lb of steam per hr at a pressure of 2000 psi and a temperature of 1050 F, with reheat to 1000 F. It is designed for gas recirculation.

*Modern Central Stations Serving America*

# Toledo Edison's BAY SHORE STATION

## Equipped with a B&W Radiant Boiler



View of Bay Shore Station, latest addition in Toledo Edison Company's expansion program, George W. Saathoff, Consulting Engineer.

Bay Shore Station—a significant addition to Toledo Edison's generating capacity—is concrete evidence of that company's policy of combining a dynamic expansion program with the latest engineering advances.

This new 135,000-KW unit, which gives Toledo Edison a total installed capacity of over ½-million kilowatts, is the latest in a $90,000,000 program carried out over the past several years. Full use has been made of latest engineering developments, including high steam pressure and temperature, reheat, and gas recirculation.

B&W Boilers such as that installed in Bay Shore Station are the product of almost a century of boiler making experience, combined with the practical advances gained through B&W's continuing program of research and development—a combination that is making basic contributions toward increasingly efficient steam-electric power generation. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, New York.

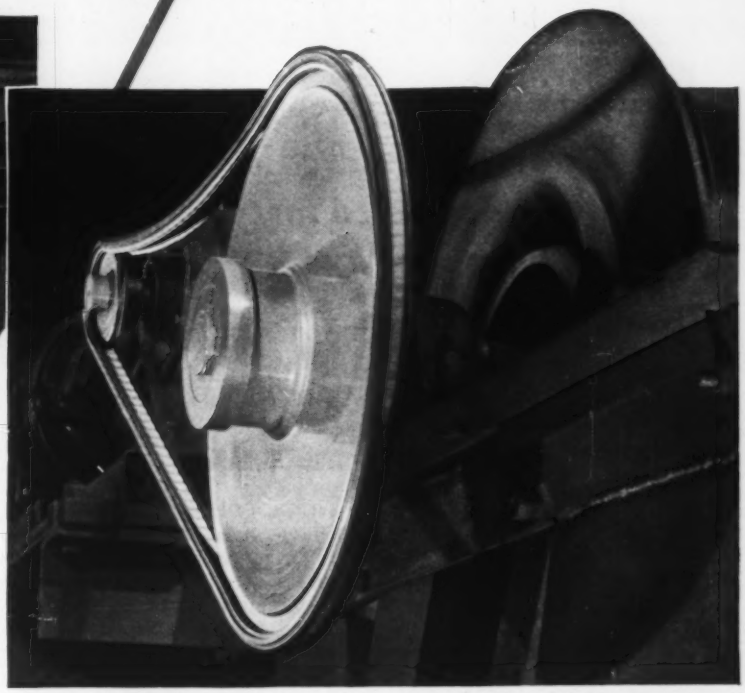
G-757

BABCOCK & WILCOX

BOILER DIVISION

It's not just static strength...

**RESISTANCE TO TENSILE STRESS** is achieved by use of properly heat-treated, accurately-machined side bars made of premium steel and fitted with properly-hardened pins, bushings and rollers. But to resist *operational* stresses, additional controls over dimensional accuracy, uniformity and roller resiliency are essential.



**STRENGTH OF CHAIN IN MOTION** is accomplished through tensile strength *plus* special Link-Belt refinements. These include pitch-hole preparation, micro-finish of parts, special processing of sidebars, prelubrication and rigid quality control from initial selection of materials to final protective boxing.

it's

# *dynamic strength*

## in LINK-BELT Roller Chain that fights fatigue

On high-speed drives or heavy conveying jobs, the components of every pitch of roller chain face severe and repeated operating stresses—engagement with sprockets, shock of starting loads, centrifugal loads and others. That's why *dynamic strength*—ability of chain to resist these stresses—is so important. And it's built into *every length* of Link-Belt Precision Steel Roller Chain.

How is dynamic strength developed? In addition to Link-Belt "extras" . . . special design, manufacturing and processing steps provide required properties of uniformity and accuracy for long-life operation.

Talk over your roller chain needs at your nearby Link-Belt office or authorized stock-carrying distributor. Ask for Book 2457, covering this complete line of single and multiple widths, in ¼ to 3-inch standard pitch, 1 to 3-inch double pitch.

14.122

**LINK-BELT gives you dynamic strength that comes from these important EXTRAS**

**PRE-STRESSING** of multiple width chain provides uniform load distribution.

**SHOT-PEENED ROLLERS** have greater fatigue life, added ability to withstand impact.

**CLOSER HEAT-TREAT CONTROL** —coupled with rigid testing insures uniformity.

**LOCK-TYPE BUSHINGS** (applied on a range of sizes) end a cause of stiff chain.

LINK-BELT

ROLLER CHAINS & SPROCKETS

**LINK-BELT COMPANY:** Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

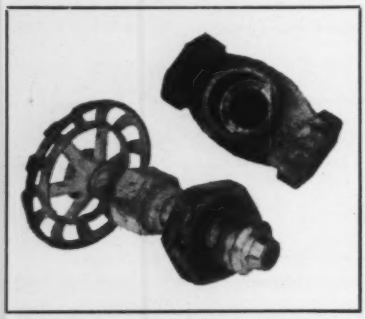


MECHANICAL ENGINEERING, July, 1956, Vol. 78, No. 7. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

# *"I got 5 years of service from a valve I expected to last only 90 days"*

*Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co., Little Rock, Arkansas plant, standing near a Walworth No. 225P Bronze Globe Valve with "500 Brinell" stainless steel seats and discs that was installed in severe boiler blowdown service. Hardened seats and discs are especially resistant to wire drawing, steam cutting, or galling.*

Some time ago Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co. plant at Little Rock, Arkansas, was having valve trouble on some newly installed boilers. The first boiler to go in service generated 600 hp operating at 200-pounds pressure. The water was so bad that a hot lime and soda ash water softener treatment had to be used, and it was necessary to add other chemicals to this solution from time to time. Mr. Worthington wanted to use a continuous blowdown to skim off the worst part of the scum on the water. He installed a small blow pipe about an inch below the normal water level in the boiler. This worked well, except that the one-inch valve on the line could only be partially opened and let a small part of the scum be blown off at one time. If the valve was widely opened, it would not take long to lower the water level in the boiler and run the steam pressure down. This service gave Mr. Worthington lots of valve trouble, as can well be imagined, because of the extreme wire drawing that occurred.



*A Walworth No. 225P Bronze Globe Valve that gave perfect performance for four years and 362 days in a severe boiler blowdown service where the Chief Engineer said he had never been able to keep a valve more than 60 to 90 days.*

One day the Walworth representatives in that area, called upon Mr. Worthington and demonstrated the outstanding features of the Walworth No. 225P Bronze Globe Valve. This valve, which has a working steam pressure rating of 350-pounds at 550°F, has a plug-type stainless seat and disc which has been heat treated to a minimum hardness of 500 Brinell. After listening to the Walworth men and examining a 225P valve, Mr. Worthington agreed that he would try one in the severe service described. He said if it lasted 90 days, he would consider that it had done a good job.

The valve went into service and came out within three days of being in service five years under very severe operating conditions. The valve was used 24 hours a day from early in the morning on Monday until Saturday night, when it was closed until the following Monday morning. It was never opened more than three-quarters of a turn, and most of the time it was opened only one-half to one-quarter of a turn. For the life of the valve, nearly five years, it never failed to give a 100% closure when shut on Saturday night until opened Monday morning.

When another 600 hp 200-pound pressure boiler went into service, it also was equipped with a one-inch Walworth No. 225P Bronze Globe Valve on the same service.

In view of the severe service and the wire drawing to which this valve was subjected, it is interesting to note that the original valve (which was taken out of service almost five years after it had been installed) was removed – not because the seat and disc were wire drawn – but because the turbulence of the steam had finally caused a small hole to occur in the wall of the body of the valve. Needless to say, the valve that was taken out of service was replaced immediately by another one-inch Walworth No. 225P Bronze Globe Valve, positive assurance that Mr. Worthington is satisfied that this valve has "done a good job."

**Other Walworth products include complete lines of Gate, Globe, Angle, Check and Lubricated Plug Valves in bronze, iron, steel, stainless steel and special alloys. Complete information and literature will be furnished upon request.**

# WALWORTH

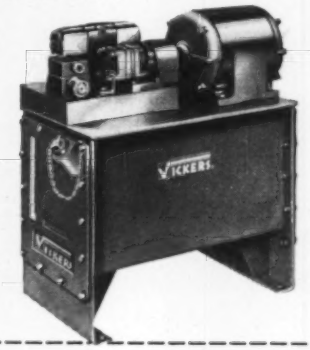
**60 East 42nd Street, New York 17, New York**

**SUBSIDIARIES:** ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION M&H M & H VALVE & FITTINGS CO.
SW SOUTHWEST FABRICATING & WELDING CO., INC. WALWORTH COMPANY OF CANADA, LTD.

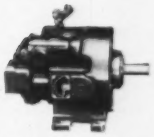
# What's New in VICKERS HYDRAULICS

**Illustrated here are new and recently improved units added to Vickers most complete line of oil hydraulic equipment. Look to Vickers as a single responsible source for integrated hydraulic systems. For characteristics of any of these components, please write for Installation Drawings by number.**

**SERIES T8 PIPELESS POWER PACKAGE** consists basically of electric motor, hydraulic pump, control circuit and reservoir. Available in 3 circuits, 3 pump sizes and 3 electric motor sizes. Inst. Dwgs. 178706, 7 & 8.



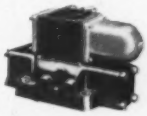
**V-LINE PISTON PUMPS AND MOTORS** for 5000 psi. Unique design minimizes relative movement between rotating parts, provides increased bearing surfaces and reduces complexity of parts. Result is improved efficiency, longer life, and reduced maintenance. Supplied with straight thread connections. Bulletin 55-72.



Variable Displacement Pump With Servo Control. Inst. Dwg. 179061. Also available with pressure compensator control. Inst. Dwg. 179060.

Constant Displacement Fluid Motor. Inst. Dwg. 179059. Available also is a Constant Displacement Piston Pump. Inst. Dwg. 179058.

DG4S4 ¼" solenoid operated. Inst. Dwg. 182412. ¼" available later.



DG5S4 ¾" solenoid controlled pilot operated. Inst. Dwg. 182413. 1¼", 2", 3" available later.

**SOLENOID OPERATED 2- AND 4-WAY VALVES** with many improved features. (1) Integral junction box (2) covers that retain the solenoids and (3) manual operation for testing. Compact and versatile. Gasket mounting simplifies installation and overhaul . . . also minimizes piping.

**TRAVERSE AND FEED CYCLE CONTROL PANEL** Improved design. Provides any cycle sequence of rapid advance, adjustable feed, dwell and rapid return motions. Maintains smooth and constant preset feed rate (either one or two) regardless of fluctuations in cutting tool resistance or hydraulic pressure.

CPP-2242 Solenoid Controlled. Pilot Operated (gasket mounted) provides smooth, low current operation. Inst. Dwg. 182414.

CG-03 Relief Valve (gasket mounted). Subplates available with pipe or straight thread connections. Inst. Dwg. 175630. CS-03 available with straight thread connections. Inst. Dwg. 175629.

CO2 Reciprocating Cycle Control Panel For Gasket Mounting. Inst. Dwg. 177083.

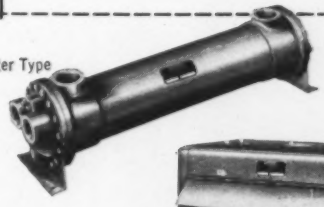
4CG-03 Pilot Operated Check Valve, gasket mounted. Inst. Dwg. 135468.

CG-714 Deceleration Valve, gasket mounted. Inst. Dwg. 172902.

CGV-06 5000 psi Relief Valve gasket mounted with straight thread connections. Inst. Dwg. 177609.

URG1 Unloading Relief Valve, gasket mounted. Inst. Dwg. 178974.

SG1 Pressure Switch, gasket mounted. Inst. Dwg. 172538.



Water Type

**OIL COOLERS** Vickers Oil Coolers are characterized by their very high rate of heat transfer per unit of space occupied. Bulletin 55-69.

Air Type

For further information on any unit shown, ask for Installation Drawing by number indicated. 7435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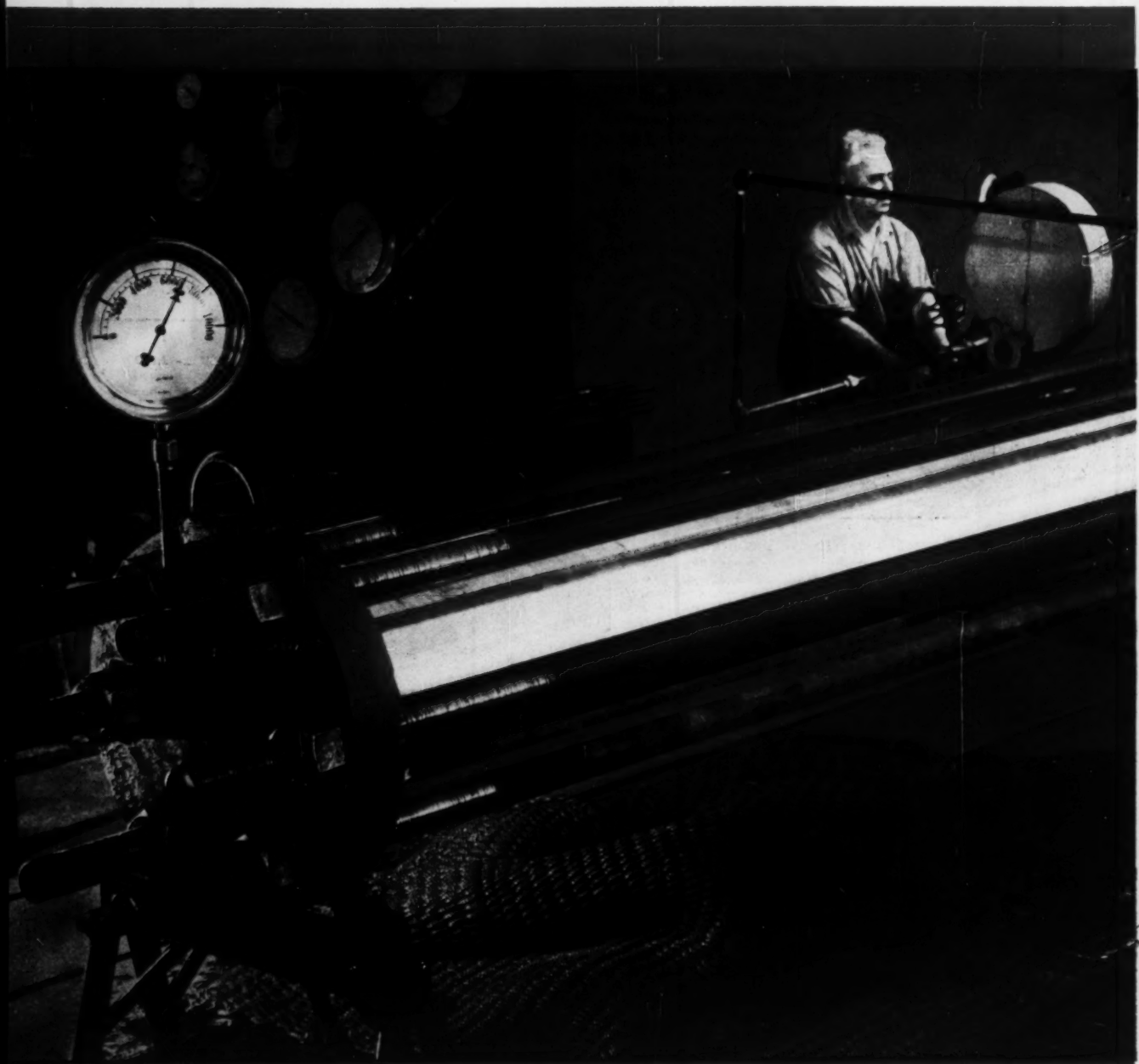
**IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto**


***ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921***

# STAINLESS STEEL CENTRIFUGALLY CAST MAY BE



ABOVE: Hydrostatic test rig used to qualify each length of pipe.

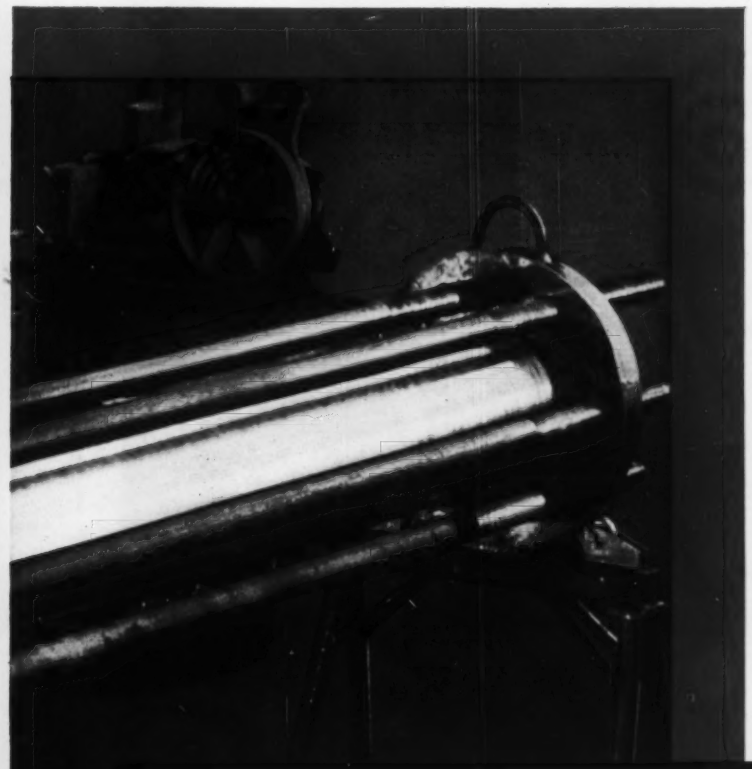
## UNITED STATES PIPE & FOUNDRY CO.

*Steel and Tubes Division*

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

# THE ANSWER TO YOUR PIPING PROBLEM



## Patented U.S.P. process meets rigid refinery specifications

The men who design today's petrochemical plants, refineries or Atomic power plants are confronted with piping problems involving temperatures, pressures and corrosive conditions which only a few years ago would have been called impractical, if not impossible.

U. S. Pipe's Steel & Tubes Division recently completed a piping requirement for 700 feet of Type 316 Extra Low Carbon, columbium-bearing stainless for a large petrochemical plant, which is typical of the job metal mold centrifugally cast pipe is doing today under a patented manufacturing process with rigid Quality Control.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses —in large or small quantities.

Write and outline your refining problems. We may be able to help.

**Note these exacting specifications on 316 Cb ELC Stainless Steel Pipe demanded by one of nation's leading oil companies:**

MATERIAL REQUIREMENTS: Pipe shall conform to ASTM Specification A-362-52T.

CHEMICAL ANALYSIS: Modified AISI Type 316 Cb (ELC), with *one percent* spread on chrome and nickel.

FINISH: Each pipe to be turned, bored and faced to surface finish of 125 micro inch or better. O.D. tolerance plus 1/16" minus 0"; I.D. tolerance plus 0" minus 1/32".

MECHANICAL TESTS: Tensile Tests—2 tests required on each pipe after heat treatment; one at room temperature, one at 700° F.

INSPECTION REQUIREMENTS

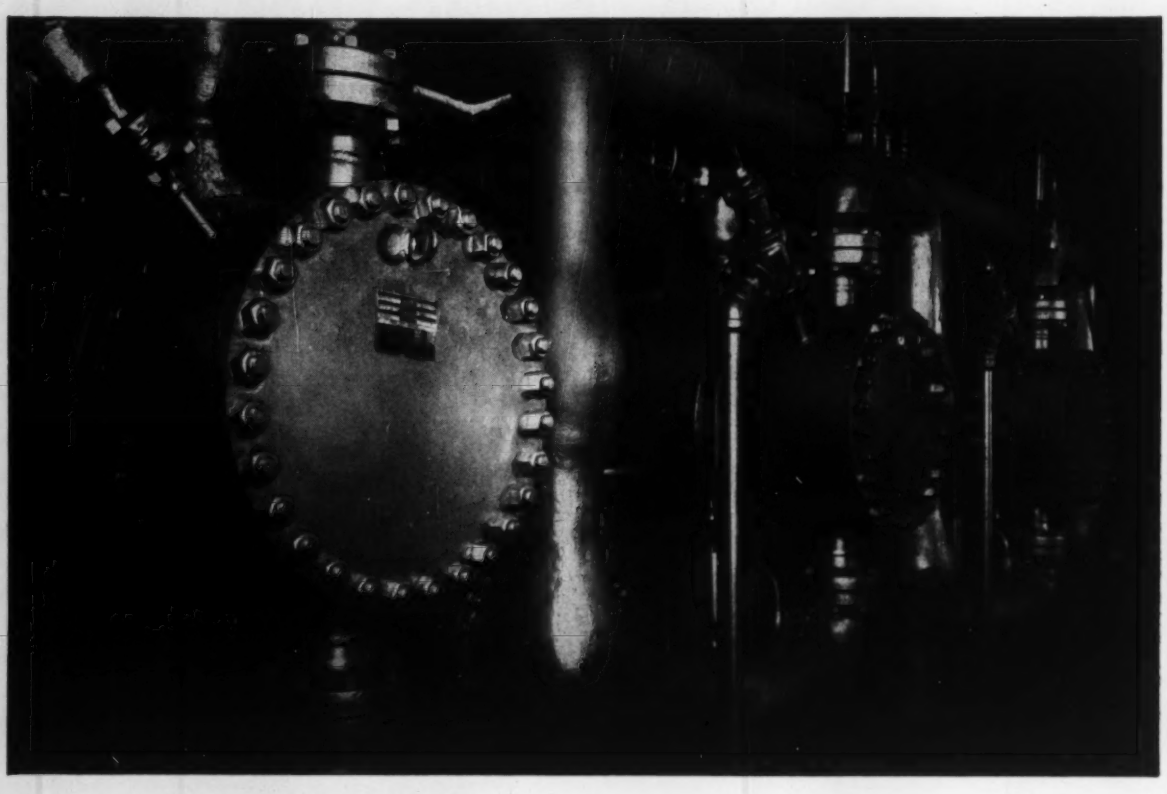
1. Etching test on sections cut from each end of pipe.
2. Radiographic Inspection—Required complete circumferential coverage of at least an 8" wide section at each end of each pipe in accordance with ASTM Specification E71-52.
3. Fluid Penetrant—Entire O.D. and I.D. surface each piece.

HEAT TREATMENT: Heat for 4 hours at 2100° F.—2150° F., water quench, follow by 5 hours at 1500° F.—1600° F. Cool in still air.

HYDROSTATIC TEST: Each length tested to stress of either 90% of the minimum cold yield strength or a maximum pressure of 6800 psi—whichever is lower.

**SIZE RANGE AND COMPOSITION FLEXIBILITY**

Outside Diameter—6" to 50"
Wall Thickness—⅜" and up
Length—Up to 16'
Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.



THE ROSS STORY

# Special Heat Exchange Equipment for Power Plants

Simply stated, Ross designs and manufactures heat exchangers for virtually all conditions and applications, particularly units of a highly specialized nature, such as high pressure power plant equipment... bleeder heaters and fuel oil heaters, for example.

The installation of 6 Ross High Pressure Fuel Oil Heaters (illustrated) at the Pacific Gas and Electric Co.'s Station P Steam Plant in San Francisco is typical. Featuring forged oil channels with integral tube sheets and a double tube sheet arrangement to insure against any possibility of fuel oil contaminating the steam system, these rugged units demonstrate Ross' resourcefulness and experience in dealing with both the average and the specialized power engineering problem.

Your requirements, too, can be met with the same, exacting Ross attention to details. Inquire now. Ross offices are in all principal cities.

For recommendations on specialized heat exchangers, as well as on surface condensers, turbine oil coolers, engine oil and water coolers, compressor inter and after coolers and related power plant equipment, you'll profit by consulting a Ross engineer.

ROSS

ROSS HEAT EXCHANGER DIVISION
of
AMERICAN - Standard

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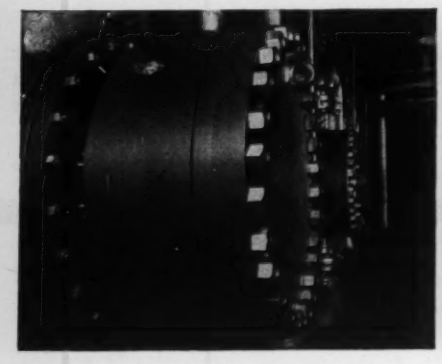
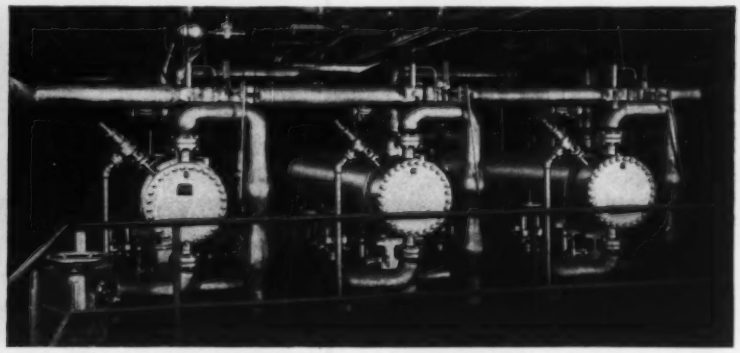
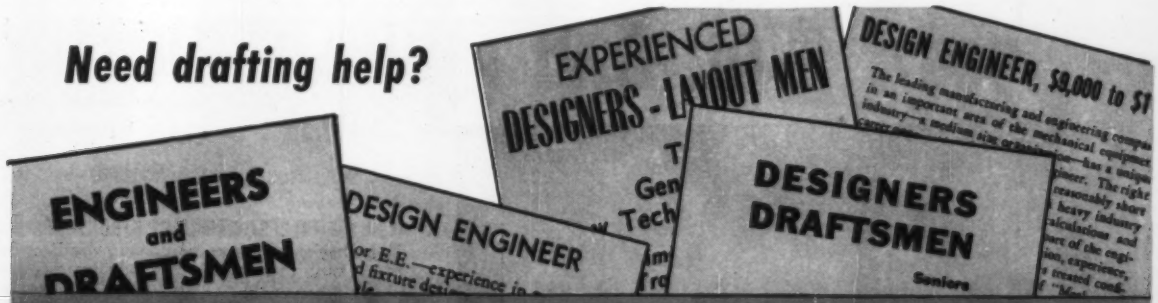




## Need drafting help?

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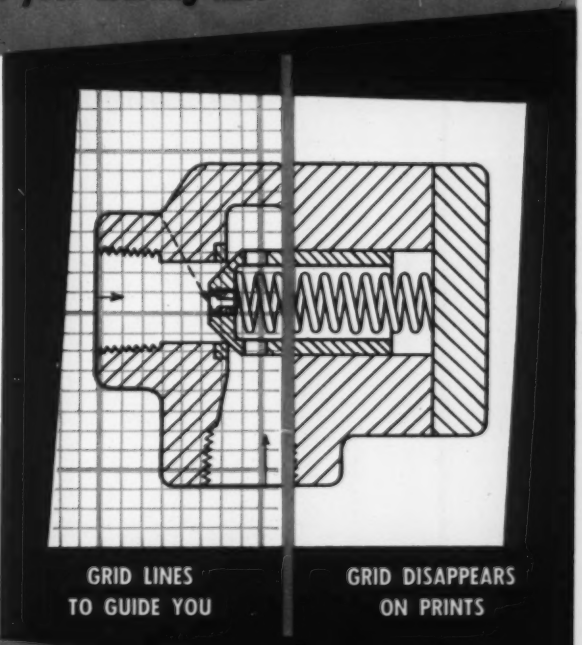


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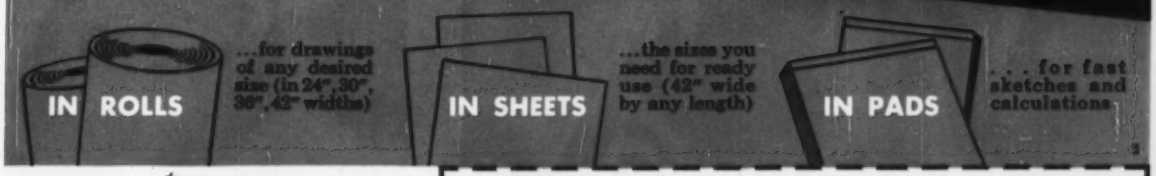
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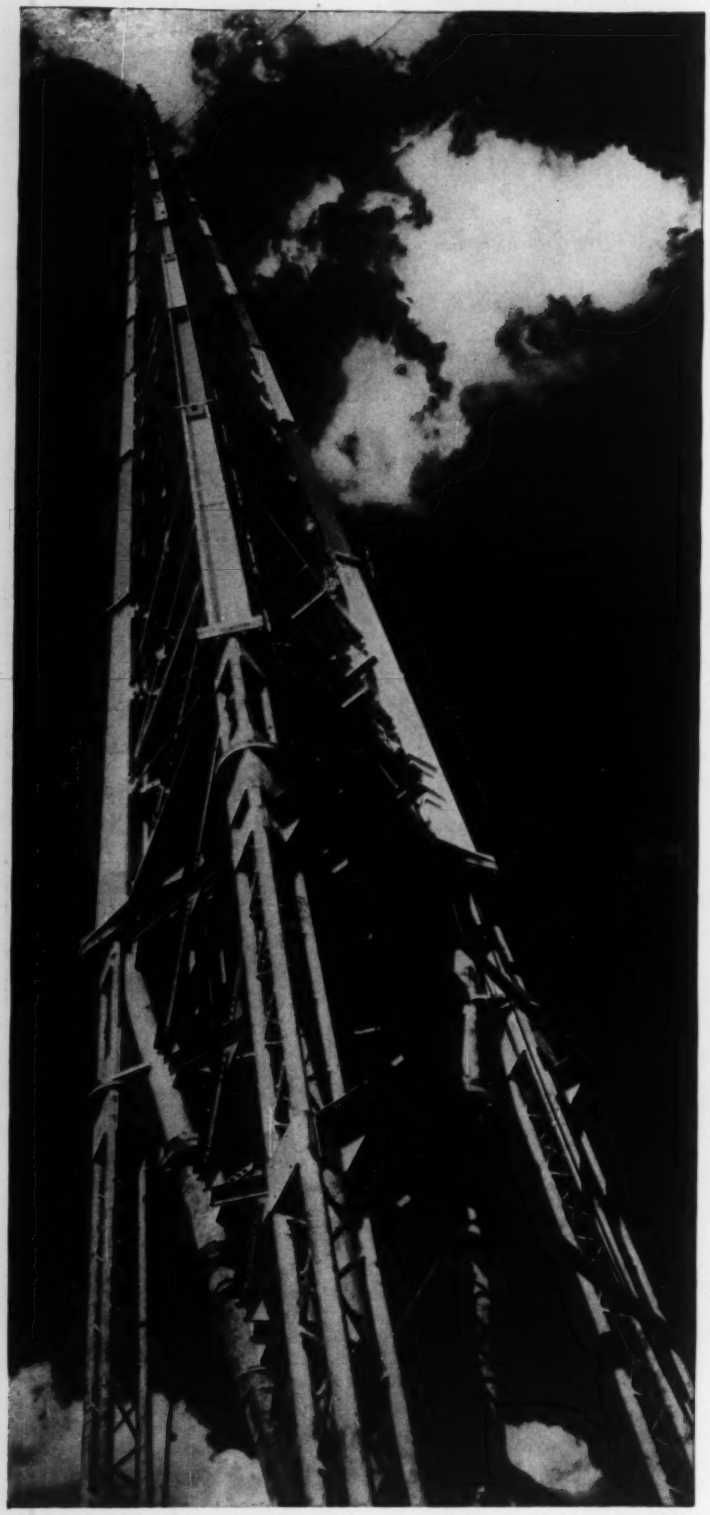

**WORLD'S TALLEST MAN-MADE STRUCTURE.** 100 ft. higher than the antenna atop the Empire State Building, the 1572 ft. television tower of Station KWTA in Oklahoma City dramatically illustrates the advantages obtainable with USS MAN-TEN Steel in structures where both great strength and light weight are imperative.

USS MAN-TEN Steel supplies the needed strength in the intermediate sections of the tower, 1050 ft. in all, where maximum diameter mild rolled steel rounds were simply not strong enough to carry the load of the tower above.

In the topmost bays, mild steel although strong enough was replaced by lighter, smaller sections of USS MAN-TEN Steel to provide greater or equal strength while at the same time reducing wind resistance so that the structure will be safe in winds up to 150 mph.

**RUGGED IS THE WORD.** Used in the body liner plates and canopy guard of this 34-ton Rear Dump built by Euclid Division, General Motors Corporation, Cleveland, O., USS TRI-TEN Steel provides 50% greater strength, 60% greater toughness and three times the resistance to atmospheric corrosion of structural carbon steel. And what is of particular importance in equipment like this, that must be able to operate all year around, is TRI-TEN Steel's ability to withstand the shock and impact of heavy, high speed loading even at sub-zero temperatures.

# with USS High Strength Steels

In USS High Strength Steels, design engineers have at their command three service-tested steels that will permit them to materially increase the efficiency and economy of machinery, equipment and structures at little or no increase in first cost . . . and frequently, at a saving.

All three of these famous *"steels that do more"*—USS Cor-Ten, USS Man-Ten and USS Tri-Ten—have a 50% higher yield point than ordinary carbon steel. All have better corrosion resistance and offer greater resistance to wear, fatigue and impact. Each, however, has specific superior properties that should be considered in determining its selection.

USS Cor-Ten Steel, for example, is distinguished by its superior resistance to atmospheric corrosion—4 to 6 times that of carbon steel. USS Man-Ten Steel is intended for weight reduction by means of greater strength in moderate forming applications, with enhanced resistance to abrasion and atmospheric corrosion. USS Tri-Ten Steel's outstanding characteristics are excellent weldability and resistance to shock at low temperatures.

Used singly or in combination, these steels can advantageously replace carbon steel to increase the strength and durability of vital parts *without* increasing their weight. Or when the use of thinner sections is feasible, they can (1) reduce equipment weight without reducing its strength, or (2) increase the size and capacity of equipment without increasing total weight or the power required to move it.

• • •

You will find our 174-page *"Design Manual for High Strength Steels"* extremely useful in applying the benefits of these steels to your product. Send for free copy—simply write on your company letterhead to United States Steel Corporation, Room 5318, 525 William Penn Place, Pittsburgh 30, Pa.

**HARD-WORKING FARM EQUIPMENT** lasts longer, is more dependable when built with USS Cor-Ten Steel. Here used in the main axle and tractor hitch frame of the famous John Deere No. 12-A Combine, USS Cor-Ten Steel gives these vital parts maximum strength, maximum toughness with no increase in weight and at the same time ensures high fatigue resistance—50% greater than that of plain carbon steel. Racking and twisting strains that could easily cause a breakdown are safely absorbed by Cor-Ten Steel's high endurance limit—and the equipment stays on the job.

**STRENGTH AND TOUGHNESS** are prime requisites in boom boats like this. Used by logging firms to buck logs in the sawmill pond to the log haul-up, these busy little vessels receive very rough treatment, are frequently squashed between the huge logs they handle. To ensure all the strength possible in the hull, sides and bottom are plated with Cor-Ten Steel, welded both inside and out. Cor-Ten Steel's greater abrasion resistance and its high resistance to corrosion also play an important part in prolonging life. (Built by the Ilwaco Boat Works, Ilwaco, Wash.)

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
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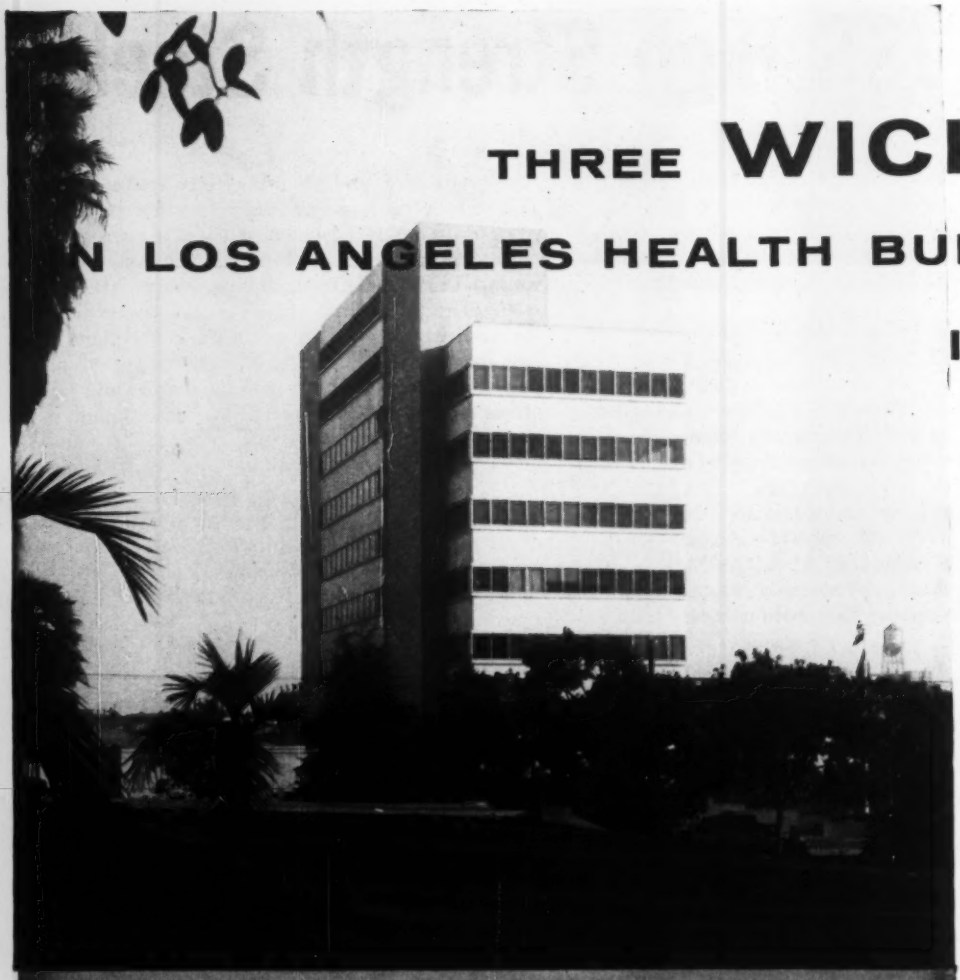
**USS HIGH STRENGTH STEELS**

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

**UNITED STATES STEEL**



THREE **WICKES**

**N LOS ANGELES HEALTH BUILDING**

**IS THE**

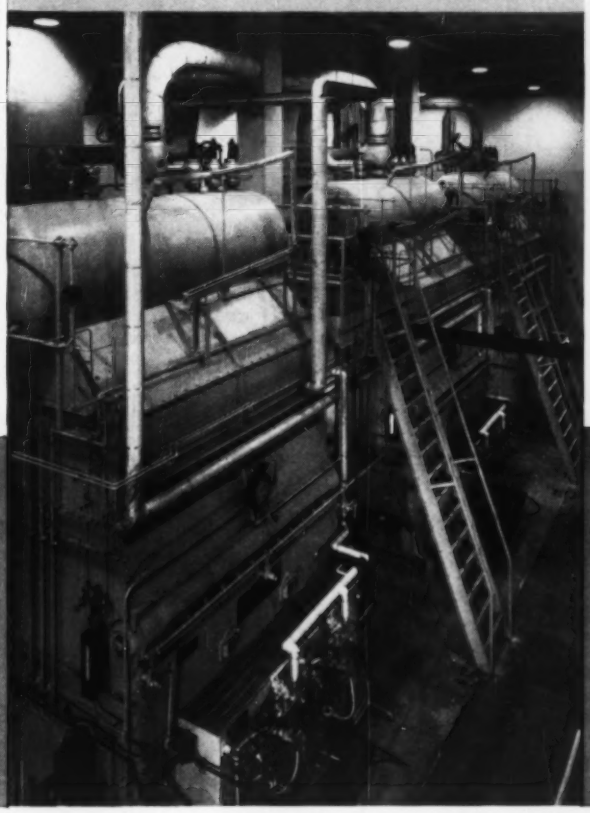
Architects: Lenden, Hayward, and O'Connor
Builder: Robert E. McKee General Contractor, Inc.

*Housed* in the striking modern structure shown here is a new clinic and health center for the city of Los Angeles Health Department. Beautifully equipped in every respect, the building has individual room thermostats to insure the exact desired temperature in each separate area . . . clinics, laboratories, medical sections, and others. To insure that the heating system responds immediately to these controls, the builders installed three dependable Wickes water tube steam generators. In addition to supplying the big nine-story Health Center with heat, the Wickes boilers also serve the entire City Hall building nearby, and the new Police Facilities building (a feature of this integrated Civic Center layout is that these buildings are connected to the Health Center by pedestrian tunnels, which are likewise heated by the Wickes boiler installation). Pictured at right is one of the modern health laboratories.

**WICKES**

# STEAM GENERATORS WHERE DEPENDABILITY MOST VITAL FACTOR

The three Wickes boilers shown below supply heat for not only the Health Center but also the City Hall and new Police building.

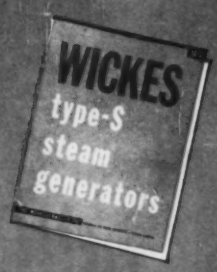


These 2-drum type-S Wickes steam generators are compact and efficient water tube units. Built to a design pressure of 160 psi, and with 3400 square feet of heating surface, each of these Wickes units is fired by 2 Multijet Combination gas and oil burners. They are quickly responsive to extreme fluctuations in load, and the large steam drums make certain of ample steaming capacity with dry steam. Wickes 2-drum type-S steam generators are readily adaptable to completely automatic control.

Other Wickes 2-drum, type-S, modern steam generators are available in the Series S1A and S2A. These units combine the water cooled furnace as an integral part of the boiler, adapting the high and low type furnace to the desired method of firing . . . coal, oil or gas. They are built to the design pressure of 725 psi; superheaters and recovery equipment are available.

**WRITE FOR OUR NEW BROCHURE**

Our new Catalog 55-2 contains complete information on Wickes 2-drum type-S steam generators. A general description is given of these modern efficient boilers, together with four insert pages of engineering drawings and data. We will also send you our complete facilities Bulletin No. 55-1.




161

## THE WICKES BOILER CO.

**DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN**

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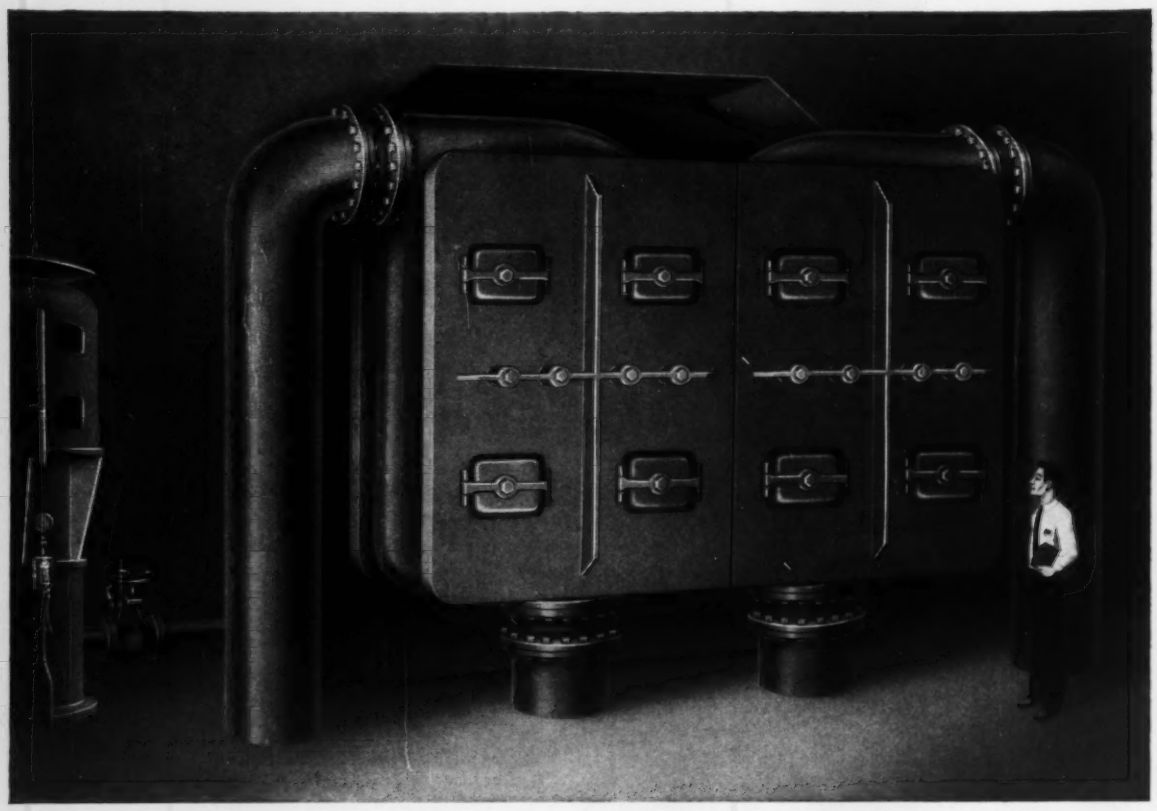

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**LOWER PRICE** Atlas Electrolized Roller Chain is as much as 40% lower in price than any other corrosion resistant chain now on the market.

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Get the facts on this new chain for use where corrosion tensile strength and long wear are important . . . as well as low cost. Write Atlas Chain and Manufacturing Company, West Pittston, Penna. Act now and

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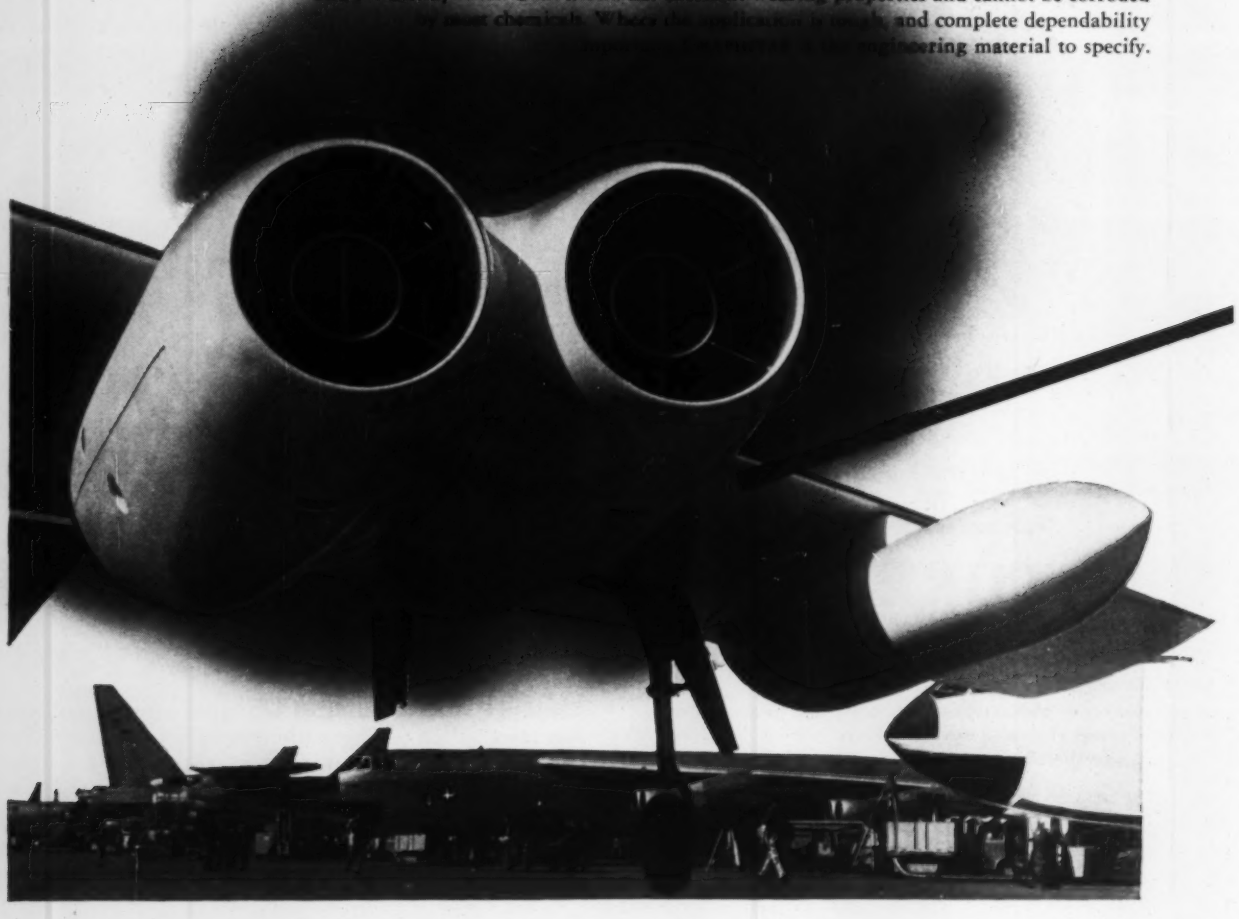
(CARBON-GRAPHITE)
# PRATT & WHITNEY J57 turbojet

● Boeing's B-52 Intercontinental Bomber, the striking arm of our Strategic Air Command, is powered by eight twin-spool axial-flow turbojet engines manufactured by the Pratt & Whitney Aircraft Division of United Aircraft Corporation, East Hartford, Connecticut. These turbojets are in the 10,000 pound thrust class and in engines of this caliber, complete dependability is vital. One of the components of the J57 is a GRAPHITAR air/oil seal employed on the turbine main shaft which, naturally, is turning at high speeds. The GRAPHITAR seal also easily withstands the maximum operating pressures developed in the engine. The slots in the face of the seal shown on the opposite page (approximately ⅔ size) are for pressure balance and cooling. This Main Shaft Seal is just one of several GRAPHITAR seals used in the J57 engine. GRAPHITAR parts can resist such taxing physical conditions because they are strong, self-lubricating, and practically inert. GRAPHITAR has excellent wearing properties and cannot be corroded by most chemicals. Where the application is severe, and complete dependability [illegible] ring material to specify.



# THE UNITED STATES

# in the engine

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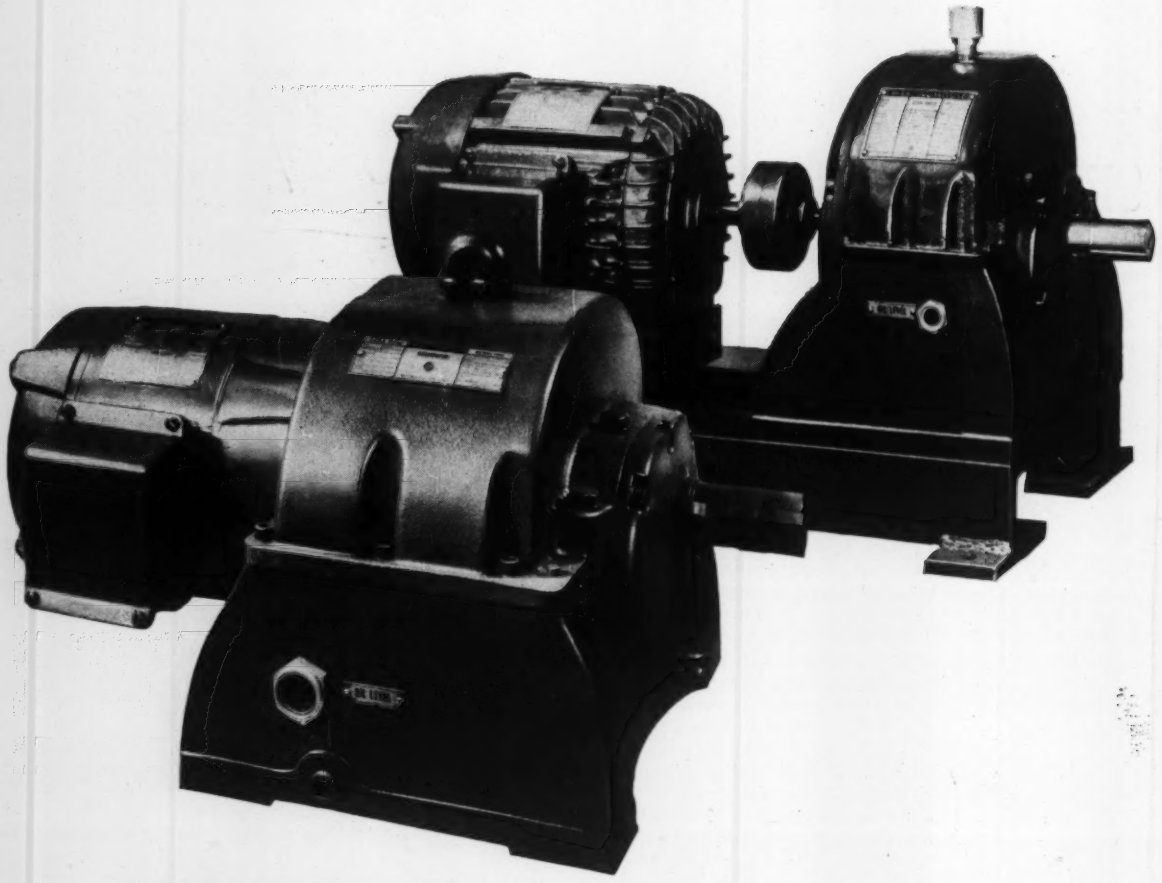
# GRAPHITE COMPANY

## DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN



# GEARMOTOR OR PACKAGED DRIVE?

## Your selection has a longer future with Westinghouse BPT gearing

Westinghouse gearmotors and DB packaged drives offer important advantages to simplify drive problems and provide long-range dependability.

First, you'll find both lines of gearing readily available. They provide a wide selection in horsepower, speed ratios, direction of power take-off, mounting and coupling methods. This sort of flexibility is bound to save you time in answering space and load problems.

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Get all the facts on Westinghouse gearmotors and DB packaged drives today from your local Westinghouse salesman; or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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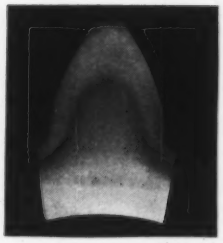

Exclusive BPT heat-treatment produces a taper hardness from surface to core of each gear tooth for toughness and hardness.

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ALUMINUM PIPING

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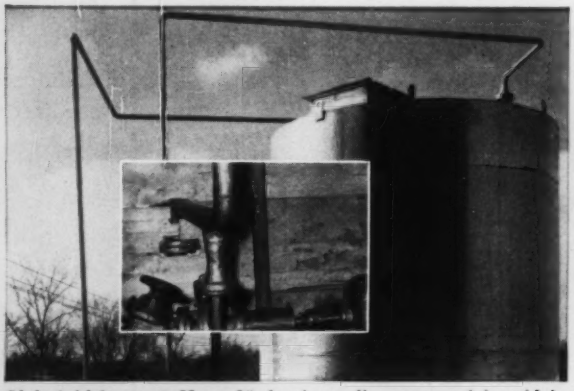
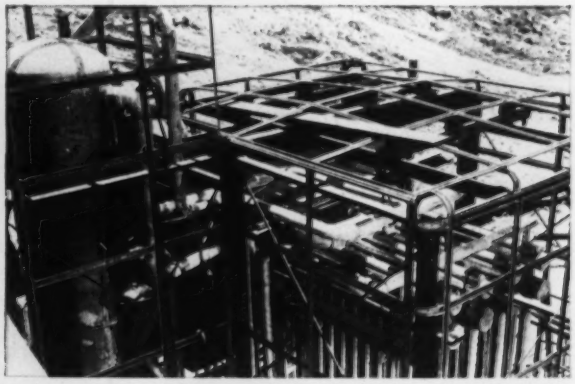
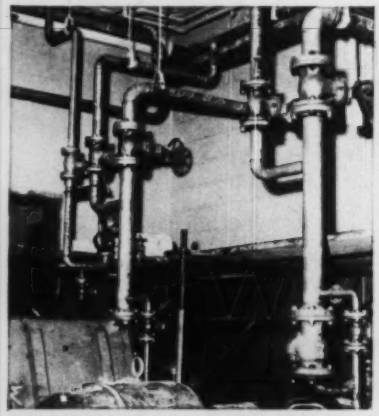
## helps you apply aluminum piping on jobs like these...



**Oleic Acid Storage:** Here, 2" aluminum lines carry oleic acid in this installation for a rubber company. TUBE-TURN Aluminum Welding Fittings are used for directional changes. Insert shows a compact combination of these fittings at a pump . . . an elbow, tee, reducer and flange.

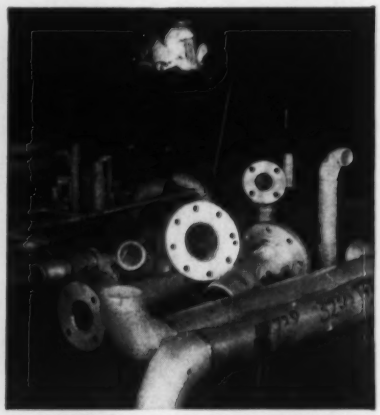


**Oxygen Plant:** TUBE-TURN Welding Fittings were used throughout this 25 tons-per-day oxygen plant for ore recovery. Here, operating temperatures range from 100°F to –320°F. Picture above shows reversing heat exchangers and fractionating tower prior to being enclosed in insulating shell.

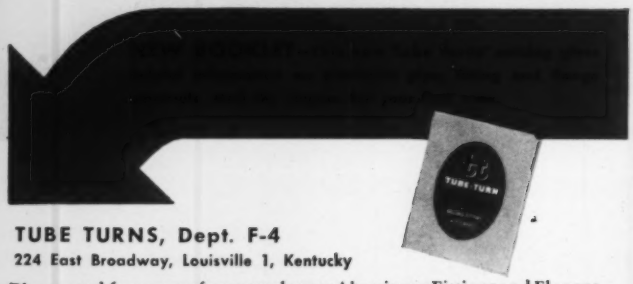


**Catalyst Piping:** Aluminum piping and fittings were specified for certain services in this new TCR bead catalyst plant to prevent contamination of the catalyst. TUBE-TURN Welding Fittings and Flanges were employed in all aluminum lines from 1" to 10". Result: Lines are permanently leak-proof – maintenance is minimized.

**Refinery Wax Coils:** Originally, retubing of seven wax sweaters in a large refinery called for coils of another metal. Switch to aluminum piping and TUBE-TURN Welding Fittings saved $50,000 in material costs! Each unit required 900 TUBE-TURN 180° Welding Returns of 1" OD.



**Fast Fabrication:** TUBE-TURN Welding Fittings and Flanges are dimensionally accurate. Rigid inspection by Tube Turns assures true circularity and uniform wall thickness. Result: Alignment is perfect; fabrication is faster; installation simplified.



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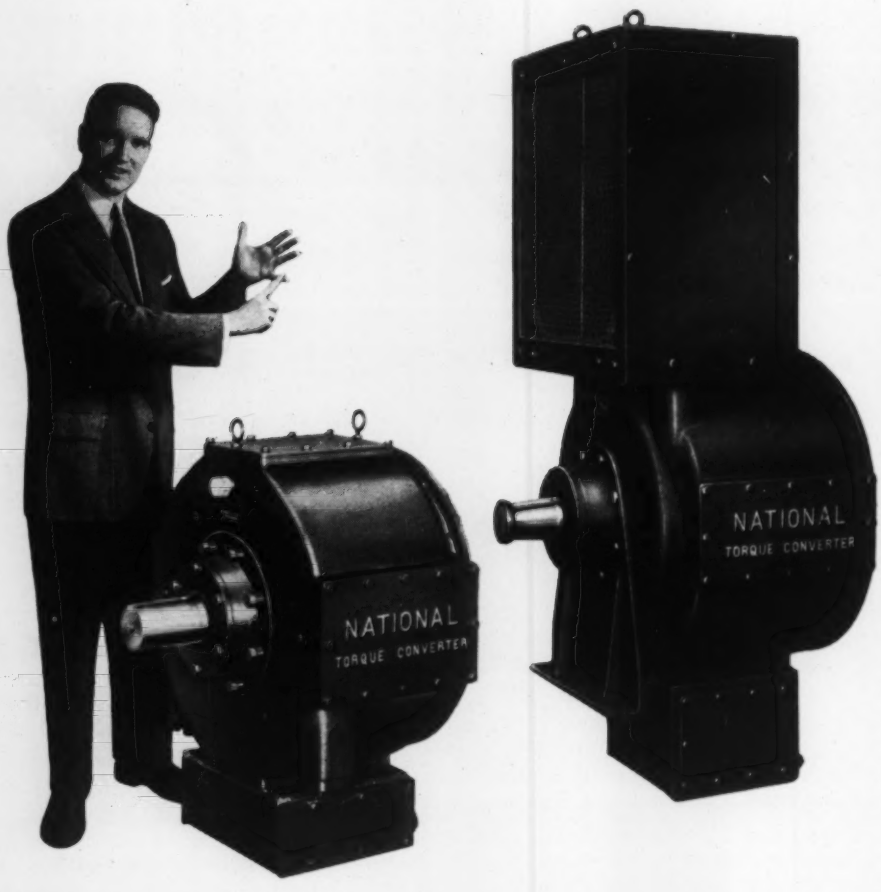
Wedge gate faces are super hard . . . hardened to 800 Brinell by Chapman's exclusive Malcomizing process. They won't . . . *they can't* seize or gall. Easily replaceable seat rings are hardened stainless steel. Wear on seating surfaces is brought to a minimum. Bolted follower on the outside screw rising stem type has no exposed threads on its yoke . . . nothing that's easy to corrode.

Made to take . . . and stand up under . . . pressures from 380 psi at 1000° F. to 2000 psi at 100° F. (For higher ratings use Chapman List 990 valves.) Sizes from ¼″ to 2″ in many different alloys. You can have either rising stem with yoke or rising stem with inside screw. And, depending upon your needs, the Bonnet joint is either ground metal-to-metal or gasketed.

Catalog 10 has full information. It's required reading for men interested in valves. Write for your copy today.

**THE CHAPMAN VALVE MANUFACTURING CO.**
**INDIAN ORCHARD, MASSACHUSETTS**

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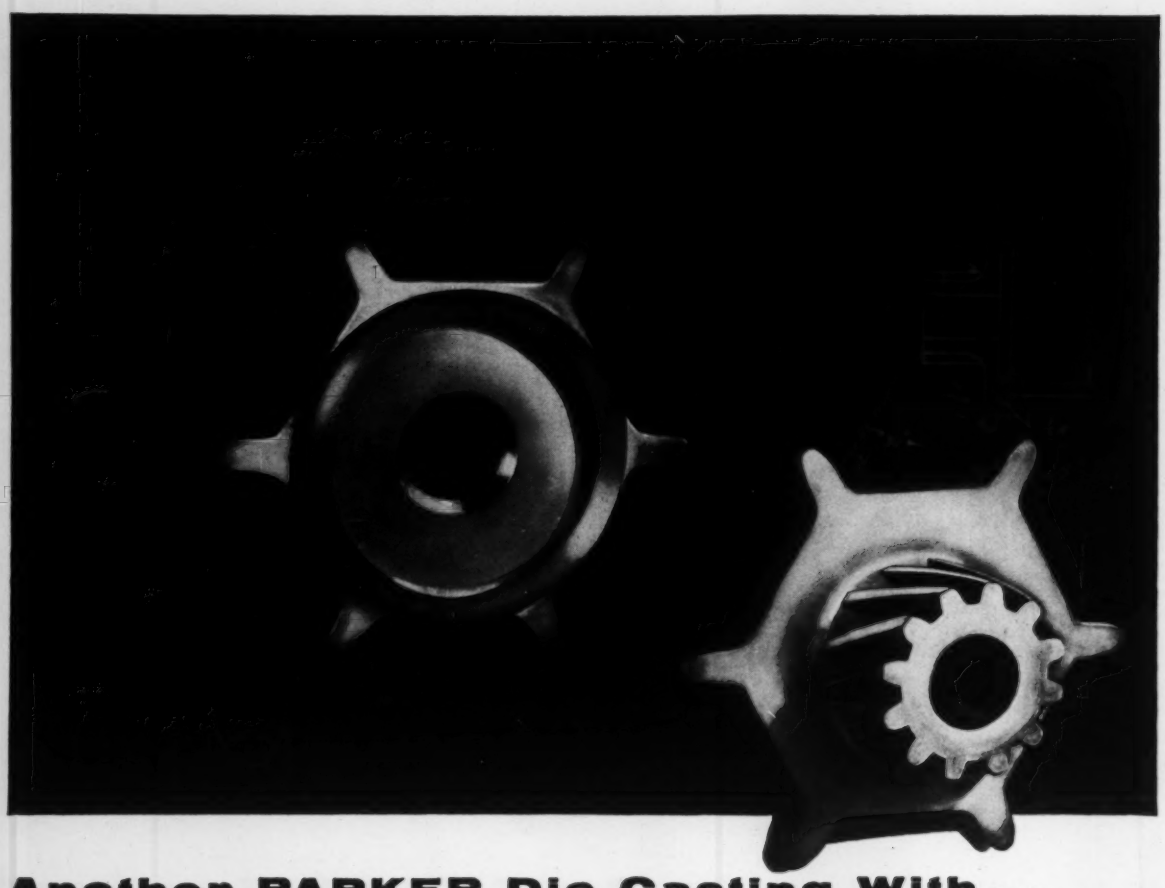

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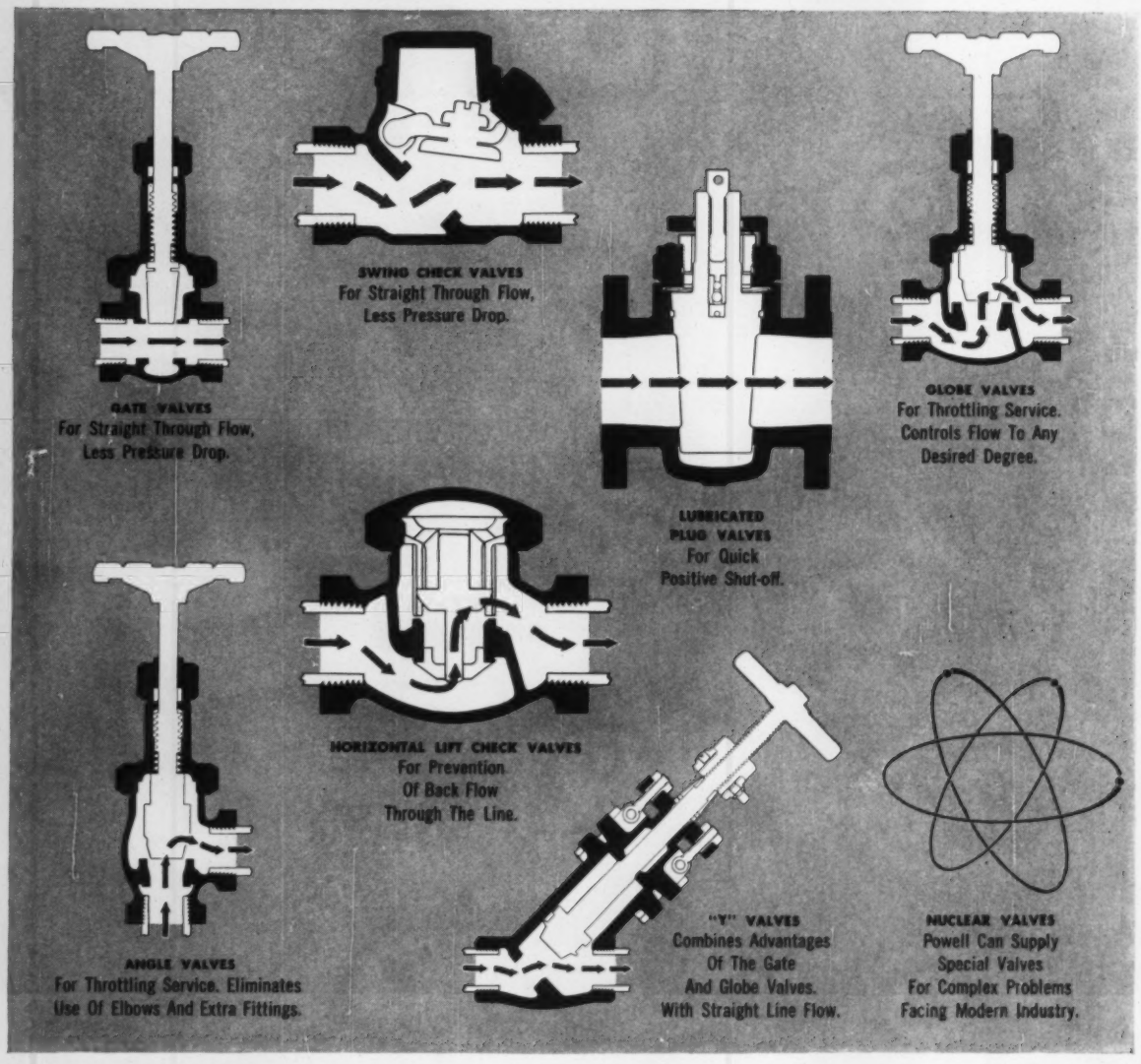
## for all valve needs




## for every flow control problem there is a right Valve

Powell can supply this right valve–*made right* of the right material*. Every part of every valve must pass rigid inspection. And as a final step in manufacture, every Powell Valve has *Performance Verified* through an *actual line test.*

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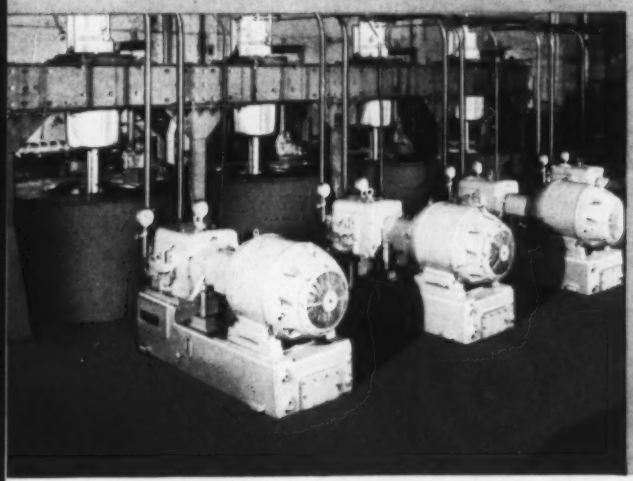
## Unique Oilgear Fluid Power "ANY-SPEED" Drives establish new production and economy records

Any desired speed from zero to maximum . . . any rate of acceleration . . . any rate of deceleration . . . any rate of hydrodynamic braking . . . any speed adjustment between operations . . . synchronization of two or more drives . . . direct or remote precision speed control irrespective of load, input power or oil viscosity changes . . . all with Oilgear Fluid Power "Any-Speed" Drives. Old and new users name them *"the drives"* for their heavy-duty needs. You probably didn't know this! Every day, people are equally surprised—*and far more amazed when they know the facts.* Write and get them *now*. THE OILGEAR COMPANY, 1570 W. Pierce Street, Milwaukee 4, Wisconsin.



### This Centrifuge at Abbott Laboratories

Leading house in pharmaceutical, drug and chemical field, Abbott's Laboratories installed first Oilgear Drive on Tolhurst centrifuge in production department. Experience was so satisfactory it led to the inclusion of another Oilgear equipped Tolhurst centrifuge in their experimental laboratories.

**SPECIFICATIONS:** Speed continuously variable from zero to 1200 rpm max. (in this case). Full control of acceleration/deceleration speed and rate. Permits that infinitely modifiable speed best suited to loading, washing, spinning and unloading.

*Photo Courtesy, Chemical Processing Magazine*

### This Centrifuge at powder plant in east

In a somewhat different application, these 4 Oilgear 60 hp "Any-Speed" Drives serve Tolhurst centrifuges in powder plant in the east. Centrifuge accelerates to 300 rpm for loading, to 900 rpm for 15-minute centrifuging, then decelerates to 70 rpm for "plowing." Unloading is automatic.

*Tolhurst is a division of American Machine & Metals, Inc.*

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*Fluid Power*

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*— in a hurry!*

Today, there's only one *best* way to order "O" Rings, and get true compression—molded quality, mass-produced, delivered in a hurry, in quantities to satisfy anyone's needs!

LINEAR, with an exclusive high-speed process, produces ROTO-MOLDED "O" Rings with precise tolerances, absolute uniformity, flash-free surface and pre-stretched grain structure—at prices that command consideration.

Regardless of the compound used, the ROTO-MOLDING process with its scientific cure control, produces "O" Rings of improved physicals.

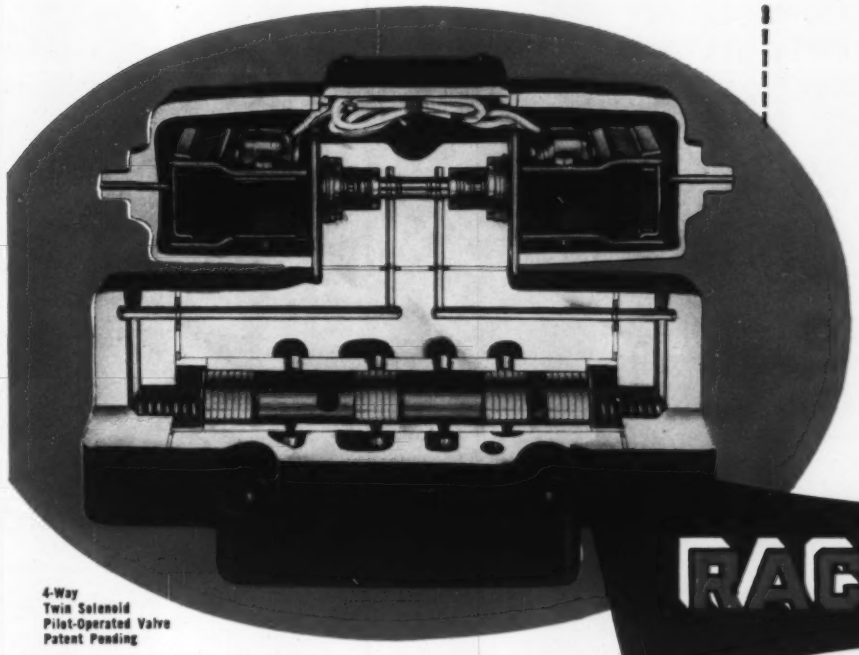
LINEAR ROTO-MOLDED perfect circle "O" Rings are produced in a variety of standard sizes and materials, plus special types and sizes for specific applications.

*Write or call Linear today for the facts!*

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.



4-Way
Twin Solenoid
Pilot-Operated Valve
Patent Pending

RACINE®

# SLEEVE TYPE VALVES GIVE BETTER CONTROL

Proper control of oil flow improves the operation of your machines.

RACINE Sleeve Type Valves are designed with round drilled parts that assure smooth, control of oil to cylinders and fluid motors.

These RACINE Valves are provided with dust-proof solenoid covers — a pending patent includes a RACINE feature that prevents solenoid operation and injury to operator when covers are removed or loose.

Built to J.I.C. specifications RACINE Valves are approved for use in all critical applications. They are precision-built, compact, and rugged in design. Operating pressures to 2000 psi with full back pressure on exhaust port.

Your machine will operate better, with less maintenance because of longer life of RACINE Sleeve construction. Write today for complete catalog showing why "Sleeve Type Valves give Better Control."

OTHER RACINE
HYDRAULIC PRODUCTS

**MODEL Q**
Variable Volume
Vane Type
Hydraulic Pump

**PRESSURE BOOSTER**
Up to 5000 psi
Up to 7:1 pressure ratio

**FLUID MOTOR**
Vane Type
50 to 3500 rpm
Pressures to 1500 psi

**RESERVOIR**
With Control Panel
Designed to your space
and circuit requirements

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**RACINE HYDRAULICS & MACHINERY, INC.**
2076 Albert Street
RACINE, WISCONSIN, U. S. A.

ARCHITECTS AND ENGINEERS: Ellerbe & Company, St. Paul, Minnesota.
GENERAL CONTRACTORS: O. W. Burke Company, Detroit, Michigan.
MECHANICAL CONTRACTORS: Johnson-Larsen & Company, Detroit, Michigan.

# COMFORTING

The Clarage fans above, located on the top floor, were sized to also take in stride the ventilation requirements of an additional five stories planned as a later expansion. In all, 17 Clarage Type NH fans, five Ready Units, a Unicoil sprayed coil unit, two Unitherm fan units, and five Propeller fans serve this hospital.

## to patients and management alike

*. . . CLARAGE Air Handling Equipment serving the new William Beaumont Hospital at Royal Oak, Michigan*

PATIENTS in this new 236-bed hospital are safeguarded by properly conditioned air handled quietly by Clarage fans and units.

MANAGEMENT for this hospital, operated on a non-profit basis by the South Oakland Hospital Authority, knows that Clarage quality can be counted on to provide successful, economical operation for a long time to come.

If faithful performance and operating economy are what YOU'RE after, we have the answer. Clarage specializes — builds air handling and conditioning equipment exclusively. Call us in for capable assistance on your next requirements. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

**CLARAGE** ***. . . dependable equipment for making air your servant***

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

# NOW... greater piping loads, longer travels, with less headroom

The Grinnell Model R Constant-Support Pipe Hanger is available now in an *extended range* of sizes to provide completely overlapping coverage of loads from 47 lbs. to 32,267 lbs., and with travels up to 12 inches. New design modifications permit these hangers to be installed with a minimum of headroom, ranging from 29 inches (rod take-out) for the largest size — down to 10¾ inches for the smallest size.

The Model R provides constant support which is mathematically perfect for all positions of travel. This constancy of support is maintained throughout the full range of field adjustability. Needle bearings minimize friction.

Grinnell Constant-Supports are individually calibrated to support the exact load specified. All Model R Constant-Supports have a full 70 percentage points of field adjustability built into them. No less than 10% of this adjustability is allowed either side of calibration for plus or minus change in load. Field re-adjustments are easily made by turning a single load adjustment bolt.

Grinnell designs, manufactures, and distributes a complete line of pipe hangers and supports for every piping requirement. Grinnell maintains an experienced staff of engineers in the field — ready to assist you on the job with any piping problem.

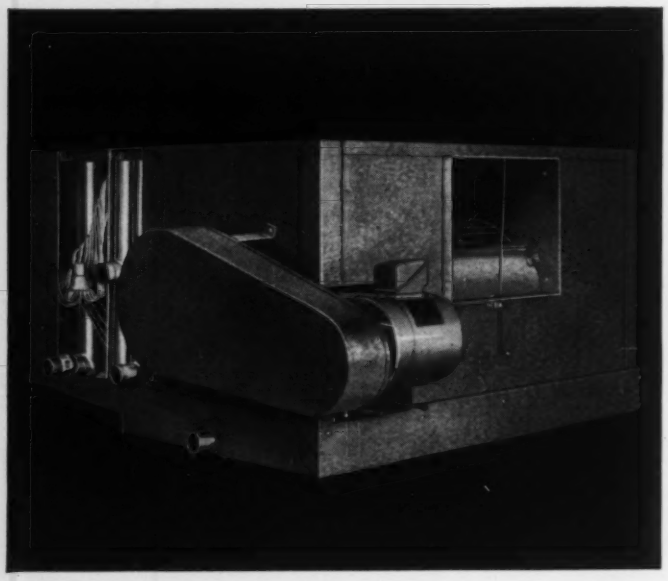
**GRINNELL**

**AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIES**

**Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

# AMERICAN BLOWER OFFERS FLEXIBILITY AND HIGH EFFICIENCY IN EQUIPMENT TO AIR CONDITION ANY SPACE

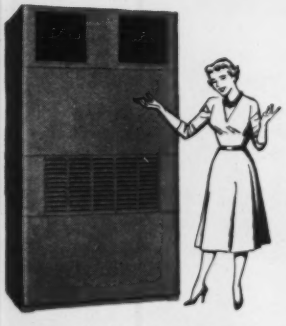


American Blower central-station cabinet-type air conditioning units cool and dehumidify in summer using chilled water, direct-expanded refrigerants, or brines; and heat and humidify in winter with steam or hot water. Quiet slow-speed fans, aileron air-volume adjustment, and air-mixing dampers combine high efficiency with accurate control to assure perfect year-round temperatures at low operating cost.

Built in sections of heavy-gauge zinc-coated steel, these units resist corrosion, make handling and erection easier. Filter boxes, piping, air discharges, and standard motors can be positioned *during installation* to meet requirements exactly. They occupy a minimum of space relative to output (capacities: 600 cfm to 48,000 cfm), and are available in horizontal or vertical arrangements, for floor or ceiling mounting.

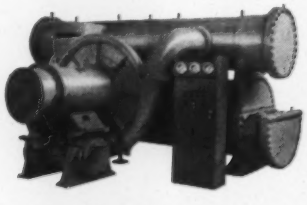
For full details on American Blower air conditioning equipment—contact our nearest branch office, or write us direct.

**Whatever type air conditioning system you plan, we have equipment to meet your exact requirements**



**Packaged Air Conditioners**—Durably finished, quiet operating, 3- thru 20-ton capacities.

**Diaflo Room Units,** for floor or ceiling mounting, offer exclusive fan design, throwaway or cleanable-type filters. Enclosures lift off by hand.



**Tonrac** —Single-Stage Hermetic Centrifugal Refrigerating Machines have few moving parts, install on single level. Completely self-contained.

**American Blower products serve industry**

- Air Conditioning, Heating, Ventilating Equipment
- Mechanical Draft Equipment
- Industrial Fans and Blowers
- Centrifugal Compressors
- Gyrol Fluid Drives
- Dust Collectors
- Refrigerating Machines

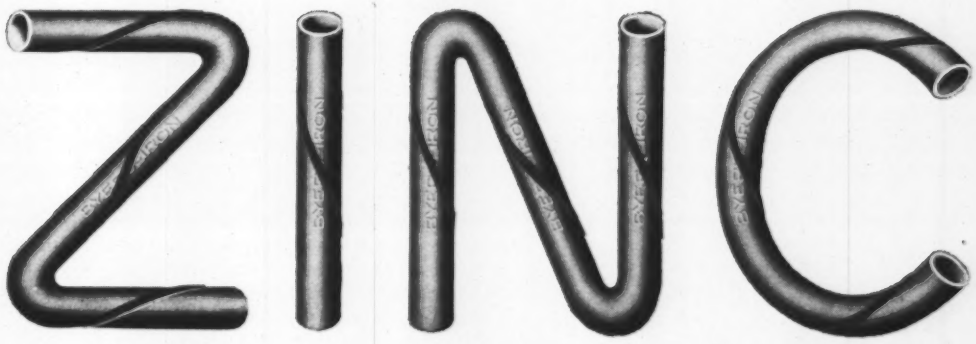
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American-Standard

**AMERICAN BLOWER**

*An engineering fact...*

# WROUGHT IRON PIPE takes up to a 50% heavier coating of ZINC

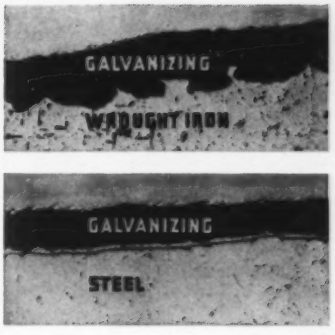



Tests prove the iron silicate fibers which give wrought iron its unusually high resistance to corrosion are also responsible for the material's ability to accept a considerably thicker hot-dip zinc protective coating than steel.

Our bulletin, *Piping for Permanence*, discusses galvanic protection, and reviews a variety of wrought iron pipe services. Write for your copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y.

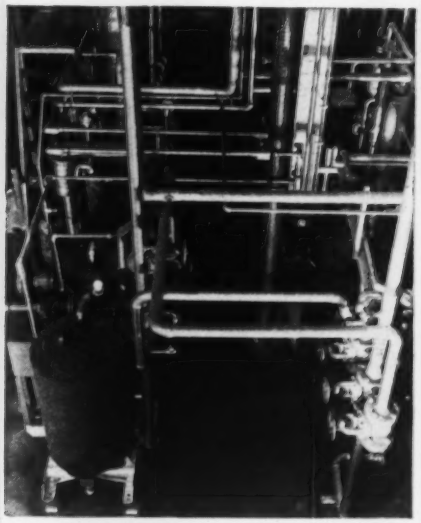
*Available in Canada and throughout the world*




These photomicrographs illustrate the ability of wrought iron to receive a tighter, heavier zinc coating. Because the life of the coating is directly influenced by its adherence and weight or thickness, zinc coating on wrought iron lasts longer.

BYERS *Wrought Iron Tubular and Hot Rolled Products*

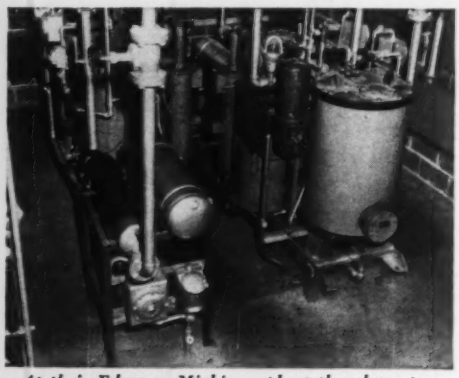
ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS



*Two BWC-250 Lectrodryers work in the gas purifying room at Carboloy's Detroit plant.*

# Because moisture would impair quality, Carboloy DRY hydrogen to −80° F.

*Lectrodryers* DRY the hydrogen used in sintering and brazing operations*



*At their Edmore, Michigan plant they have two BWC-250 Lectrodryers in the power plant.*

MOISTURE in the hydrogen used to fire sintering furnaces would break down, freeing oxygen. This would form oxides, causing inclusions in carbides. It would consume the aluminum intended for alloying in magnets. Carboloy, Department of General Electric Company, avoids those hazards by removing every trace of moisture to dewpoints below −80°F.

Carboloy's cemented carbides, Hevimet and Alnico permanent magnets are all produced in hydrogen-fed furnaces. You see one here. As evidence of the extensiveness of these operations, the Detroit plant alone is capable of producing a million cubic feet of hydrogen a week. Lectrodryers can DRY that volume, staying on-stream continuously, without interruption.

Metallurgical operations elsewhere similarly employ gases dried by Lectrodryers. Your manufacturer of controlled atmosphere generators can advise you on their use, where DRY gases are indicated.

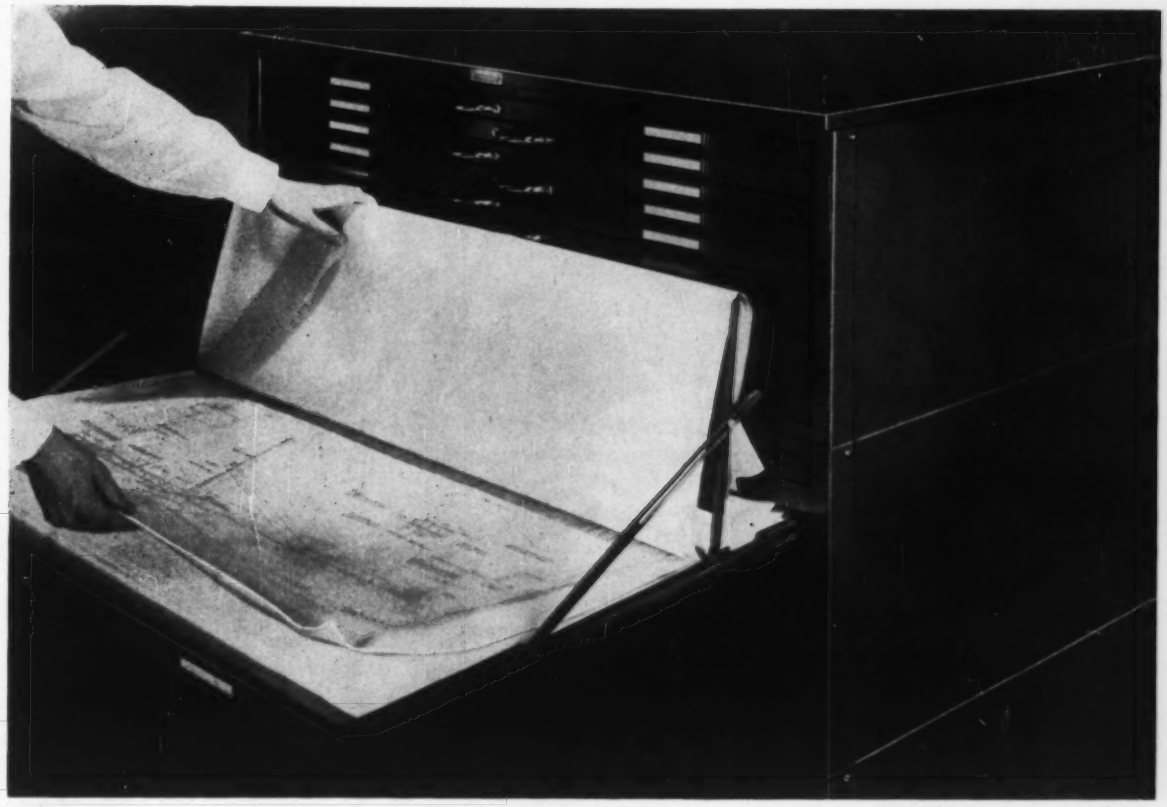
Pittsburgh Lectrodryer Company, 335 32nd Street, Pittsburgh 30, Pa. (a McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

**LECTRODRYER**

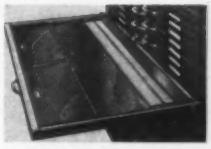
* REGISTERED TRADEMARK U. S. PAT. OFF.



# 1000 tracings... all easily accessible ... in 15⅜ inches!

This Hamilton Shallow-Drawer unit, only 15⅜" high, safely stores 1000 of your most active tracings. Yet you can easily remove and refile any one of them because of the exclusive *tracing lifter* in each drawer.

Hamilton builds outstanding units for every storage need. Many units interlock in a single, compact UnitSystem to give you a variety of special purpose filing units in a single-bank assembly. See your Hamilton dealer or write for complete UnitSystem information.

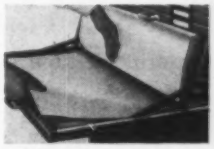


**Keeps contents flat**

Each drawer has a mechanical tracing lifter that also keeps contents flat when drawer is closed.

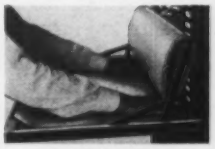
**To find drawing**

Raise front half of tracing lifter and locate desired drawing. Rear half still holds contents firmly.



**Removing sheet**

Sheets above desired drawing are turned over lifter and folded back. Sheet is easily removed.



**Refiling sheet**

Drawing is refiled as easily as removed—flat and smooth, ready for many future references.

Many Hamilton units (5-Drawer, Shallow-Drawer, Vertical Drawer) interlock into a single UnitSystem installation—building storage space *upward*, saving floor space. UnitSystem equipment is available in sizes to fit your filing requirements.

**Hamilton®**

DRAFTING EQUIPMENT

HAMILTON MANUFACTURING COMPANY • TWO RIVERS, WISCONSIN

***No dezincification*** after Ni-Vee bronze parts replaced manganese bronze stems in water system valves such as these produced by water works equipment manufacturer, Rich Mfg. Co., Los Angeles, Calif.

# How Ni-Vee bronze valve stems halt failures in water system

VALVE STEM BREAKAGE puzzled and plagued water system engineers in the City of Los Angeles.

Cause of the trouble? Dezincification. A form of corrosion that sapped strength from manganese bronze stems in cast iron valve bodies.

Finally city engineers found the answer. As a result of 5-year tests of copper-base alloys in a variety of waters, these engineers turned to valve parts cast in Ni-Vee* nickel-tin bronze.

### *High mechanicals*

Containing less than 2% zinc, mainly for scavenging in the melt, Ni-Vee bronze stays immune to dezincification. Thus, it retains its original strength indefinitely. But that's only part of the story.

Ni-Vee bronze gives you high "as cast" tensile strength which simple heat treatment can lift up to 90,000 psi. In addition, this bronze resists wear, impact and galling. It offers easy castability, low shrinkage, pressure tightness, fine grain. Versatility plus economy.

Avail yourself of the money-saving advantages afforded by this simple family of five outstanding Ni-Vee bronzes. Use them anywhere copper-base cast alloys have application for pressure, constructional and bearing needs. And write for your copy of *"Engineering properties and applications of NI-VEE BRONZES."* Do it now. *Registered trademark

INCO NICKEL ALLOYS **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

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JULY 1956

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*Published by*

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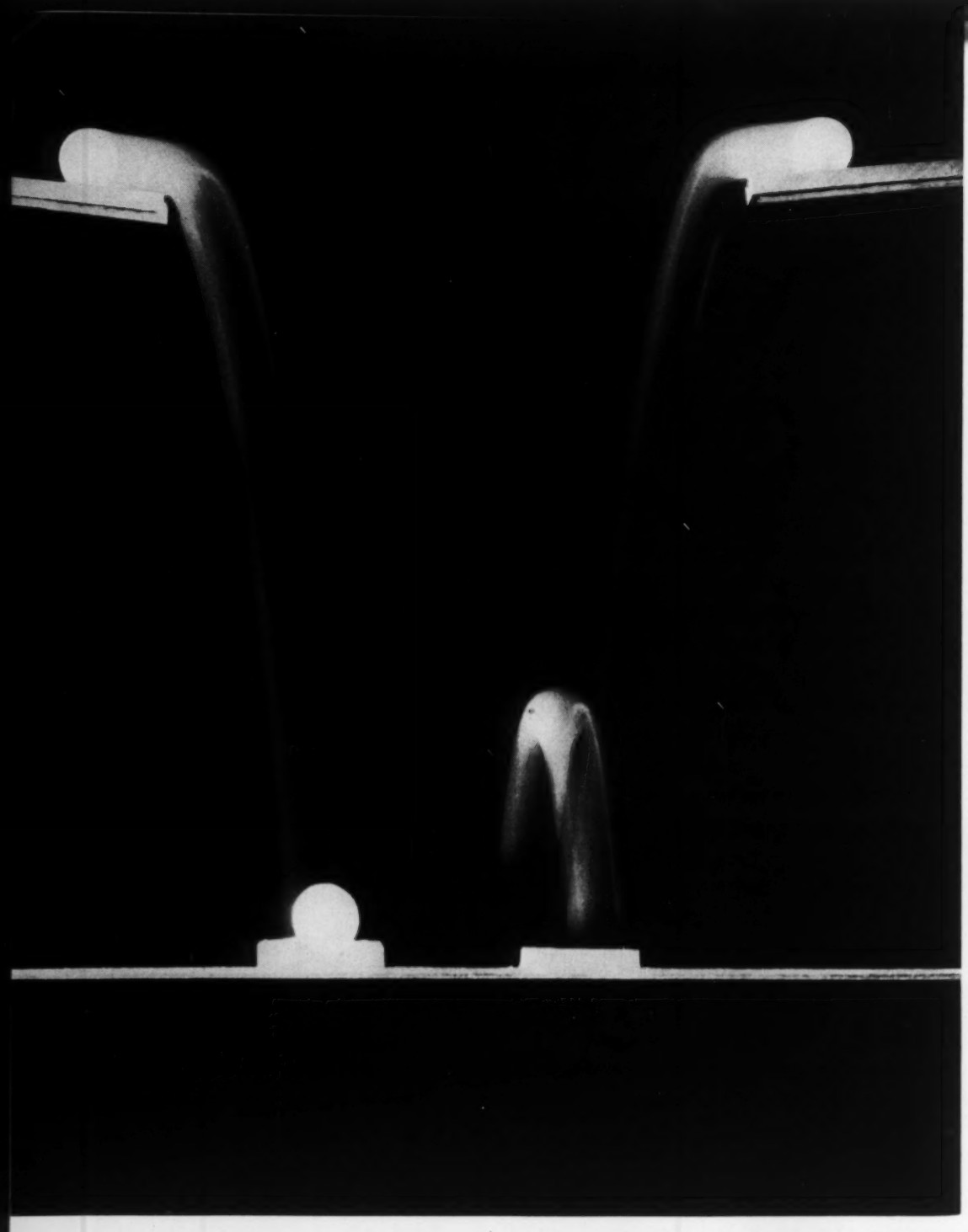

## How to put bounce into silicone rubber . . .

. . . by bombarding it with "atomic bullets" in the form of high-speed electrons is demonstrated here by a sample of silicone gum before and after exposure to radiation. The falling ball, *left,* sticks to the original puttylike silicone gum. But after a two-second bombardment with electrons which have accelerated to 2,000,000 volts, the silicone is vulcanized and has the bounce of natural rubber, *right.* Now done only on a laboratory scale by scientists at Westinghouse Electric Corporation, the process produces a better rubber than ordinary vulcanization, which requires chemicals, heat, and many hours of curing time.

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JULY 1956

•

George A. Stetson, *Editor*

# MECHANICAL ENGINEERING

## Harvey F. Mack—Printer

ENGINEERS have good reason to acclaim the services rendered to them by Harvey F. Mack, printer, who died on May 29, 1956, for the high quality of composition, proofreading, and presswork which characterize the publications of many learned societies, including those of The American Society of Mechanical Engineers, produced by the Mack Printing Company for a period of more than 50 years.

The skills of the mechanic arts are handed down directly from master craftsman to apprentice, but the technical knowledge required by scientists and engineers must be stored and made available in the printed word. Hence the publications of organizations like ASME constitute the most permanent and tangible heritage which one generation passes on to the next and a good printer becomes a necessary and valuable partner in the progress of mankind.

When Harvey Mack entered the printing business he devoted himself particularly to the needs of scientific and engineering societies and specialized in that area of the printing art which requires the highest skill of the compositor and meticulous care on the part of proofreaders. He employed and trained personnel for these exacting tasks and as demand grew for this type and quality of printing, he expanded his plant and organization. He rightly imagined that he was playing an important role in the progress of science and engineering and instilled in his employees a feeling of pride in their work and a sense of responsibility to see to it that it was honestly, competently, and efficiently carried on.

Because printing is a major item of expense in the budget of ASME, the relationship between the Society and its printer must be based on a common objective and cordial understanding. For years the ASME Editorial Department and the employees of the Mack Printing Company have worked together harmoniously because Harvey Mack looked upon them as a single team and insisted that the interests of the Society should be a major concern of the persons on his payroll.

Although Harvey Mack became a printer more through pressure of circumstances than by design, it remains to his credit that he had the imagination and courage to make the most of the opportunities he found and the energy and business judgment to develop them into a useful and profitable enterprise. His humble heritage included qualities which others recognized and encouraged while he himself was too young to assess their potentialities. A frank, enthusiastic, and likable personality inspired confidence which was justified in the performance of tasks assigned to him as a young man when he first demonstrated that sense of responsibility for the interests of others which was characteristic of him throughout his life. His career typifies the best traditions and rewards of the American way of life.

Harvey Mack was born in Phillipsburg, N. J., and attended the public schools of Easton, Pa., across the Delaware River. For two years after graduation from high school he worked as a stenographer and bookkeeper. In 1900 Dr. Edward Hart, father of one of Harvey's classmates, persuaded the young Mack to enter the printing business. Dr. Hart, head of the Chemistry Department of Lafayette College, was also editor of the *Journal of the American Chemical Society* and operated the Chemical Publishing Company on the brow of the Lafayette campus. With the sudden death of his son in 1901, the grief-stricken father took a six-month trip to Bermuda, leaving Harvey with power of attorney and responsibility of the printing business. He handled the business to the complete satisfaction of Dr. Hart, and in 1902, with Charles A. Hilburn, he formed a partnership to manage the Chemical Publishing Company. The following year the partners purchased the controlling stock of the Eschenbach Printing Company of Easton, which became the Mack Printing Company in 1926. Mack began printing MECHANICAL ENGINEERING in 1920 and Transactions in 1928, and for many years has produced a major portion of other ASME publications.

In 1902 Harvey Mack hired a young woman whom he had met at the Methodist Church and to whom he was married in 1911. Her sister, Miss Helen W. Smith, had been a proofreader for Professor Hart and remained with the Mack organization. On the abilities and devotion of these two women rests a large measure of the success and reputation of the Mack Printing Company. To Miss Helen Smith, who died in 1946, goes the credit of organizing and maintaining the high standards of proofreading for which the company is known. Mrs. Mack, who survives her husband, is treasurer of the company which has always leaned heavily on her sound business judgment. Without mention of these remarkable sisters, no tribute to Harvey Mack would be complete.

Space does not permit mention of the untiring services which Harvey Mack rendered to the community in which he established himself as one of its most distinguished and beloved citizens, or to list the many learned societies and technical magazines for which he was printer. Through his enterprise he gave employment to hundreds of his fellow townsmen, many of whom he had watched grow up, marry, and raise families. These people were his family. He knew each personally and shared their joys and sorrows. On his seventy-fifth birthday they said of him: "His good deeds have made the world a better place, and it is right . . . . that he be made aware of the esteem of those who have benefited from the opportunities for work and service his vision and sound leadership have provided."

# Nuclear Gas Turbines[1]

*Symposium covering the applications of various gas-turbine power systems to nuclear reactors*

## The Closed-Cycle Plant[2]

THE closed-cycle gas-turbine power plant has been under development by the firm of Escher Wyss Ltd. of Zurich, Switzerland and its licensees for the past 15 years. During this time some dozen or so plants have been placed in operation, or are in the process of being built, ranging in output from a 500-hp plant for research purposes to a 12,500-kw plant for central-station use. Fuels burned have ranged from distillate to residual oils and from peat to slack. Terminal efficiencies have ranged from 20 to 30 per cent, depending upon the complexity of the plant and the design conditions.

### Nuclear-Heat Source

The prime requirement of a nuclear-heat source for a gas-turbine power plant is that it be capable of delivering its thermal energy at reasonably high temperature levels. By reasonably high temperature levels we mean of the order of 1200 to 1500 F in the working fluid. If this cannot be done, then there is little point in considering the heat released from a nuclear reactor as a useful source of thermal energy for a gas-turbine plant.

In making use of this heat we can follow along the lines as presently practiced and "cool" the reactor and then transfer the heat from the coolant to a thermodynamic working fluid through a transfer loop or we can take the direct approach, along the lines first proposed by Farrington Daniels 10 years ago, and remove the heat from the reactor directly with the power-plant working fluid. Fortunately, the use of a closed-cycle gas turbine offers the possibility of the use of a number of working fluids. They are clean and uncontaminated, do not undergo a change in state, are stable, and can be heated through an appreciable temperature range without any change in properties, do not exhibit the characteristics of a universal solvent, and in short, have every consideration for the reactor. There are problems to be solved, to be sure, but they are high-temperature problems of the reactor and not of the working fluid.

Recalling to mind the flow diagrams of pressurized-water, liquid-metal, and homogeneous steam systems the simplicity of the closed-cycle gas-turbine nuclear plant can be appreciated from an inspection of Fig. 1.

***Character of Nuclear Heat.*** The next question is regarding the character of nuclear energy and how we can best put it to use. Fissionable materials used as a heat source differ from fossil fuels by their enormously greater concentration of energy in a given volume.

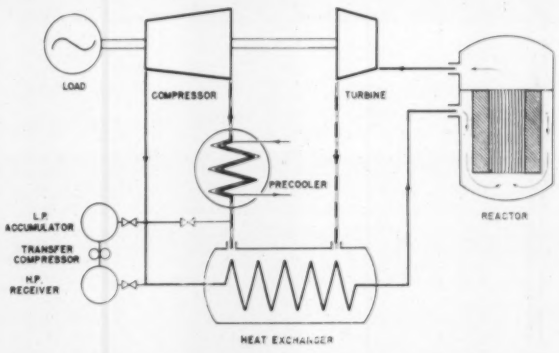


Fig. 1 Closed-cycle gas turbine with nuclear reactor

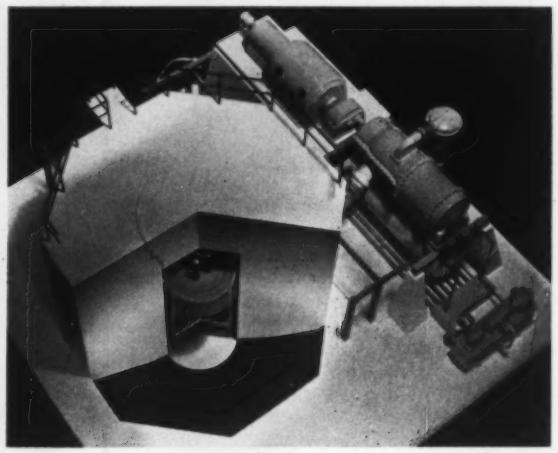

Fig. 2 General arrangement of small closed-cycle gas-turbine nuclear power plant

Because of this characteristic there are applications where a definite benefit will be gained, such as in transport vehicles, where refueling cannot readily be done, or for the production of power in locations which are too remote or too inaccessible to justify the transportation of fossil fuels or electrical energy but where the availability of power is a military necessity or will make the industrial development of the area possible.

Since these areas call for a propulsion plant or a plant that is readily transportable, the use of an enriched fuel is dictated. Since enriched fuel is natural fuel, concentrated by an elaborate and expensive process, it should be used in a power plant having a high thermal efficiency. This can be done in a closed-cycle gas-turbine nuclear

[1] Based on four papers comprising the First Annual Symposium on Nuclear Gas-Turbine Power Plants, sponsored by the Gas Turbine Power Division and held by the Washington Section, Washington, D. C., December 8, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Condensed from paper, "The Closed Cycle Gas-Turbine Nuclear Power Plant," by S. T. Robinson, Vice-President, American Turbine Corporation, New York, N. Y.

Table 1 Comparison of Nuclear Power Plant Characteristics

| Type of power plant | Closed-cycle gas turbine | Steam | Steam |
|---|---|---|---|
| Working fluid | Helium | Steam | Steam |
| Reactor coolant | Helium | Water | Sodium |
| Relative output, per cent | 100 | 90 | 100 |
| Relative plant weight, per cent | 100 | 151 | 156 |
| Relative shield weight, per cent | 100 | 151 | 196 |
| Relative total weight, per cent | 100 | 151 | 174 |
| Relative volume, per cent | 100 | 167 | 152 |

Source: Crever and Trocki, "Nuclear Power Plants," *Electrical Engineering*, April, 1954.

power plant operating over an efficiency range from 20 to 40 per cent, depending upon the temperature levels and the degree of complexity of the plant.

### The "Package" Reactor

There has been a great deal of talk in recent months of a package reactor, implying that if the reactor is "packaged" the problem of building a packaged power plant is solved. This is hardly true as it does not account for what is necessary to make the heat generated in the "packaged reactor" available to the user. Several studies have been made along these lines and one on which data have been released makes a comparison of nuclear power-plant weights and volumes, using a closed-cycle gas-turbine system and two steam systems in which steam is raised by heat removed in a pressurized water reactor and a sodium-cooled reactor. These data are given in Table 1.

These data point to the fact that a closed-cycle gas-turbine system weighs about 70 per cent as much as a pressurized water system (PWR) and about 55 per cent as much as a sodium system. Volumewise the closed-cycle gas-turbine system requires about 60 per cent of the space of the PWR system and about 70 per cent of the space of the sodium system. It is unfortunate that comparative data are not available on the weight and volume of a boiling-water reactor system.

As regards configuration, the closed-cycle gas-turbine power plant can be designed in many forms to suit a particular application. Fig. 2 illustrates the general arrangement of a small closed-cycle gas-turbine nuclear power plant using nitrogen as the working fluid. This general arrangement is suitable for a plant for the generation of electrical power and we believe the arrangement is suitable for outputs up to about 10 mw.

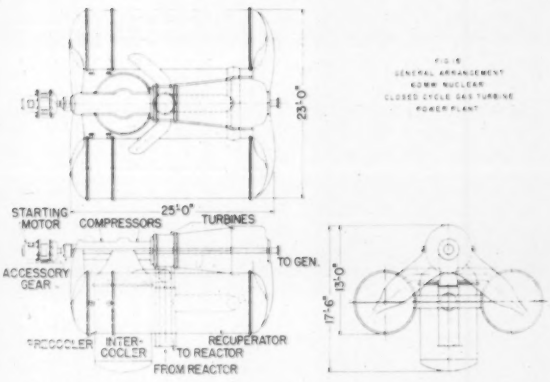


Fig. 3 Machinery and heat-transfer group for 60 mw nuclear power plant

Plants of greater output necessitate a different design approach. Fig. 3 illustrates the machinery and heat-transfer group for 60 mw nuclear plant using helium as the working fluid. This general arrangement is suitable for ship propulsion plants from 20 to 50,000 hp, or for electrical generating plants from 15 to 250 mw. In an electrical plant the maximum output is only limited by the unit size of a 3600-rpm generator.

### Fields of Application

We are of the opinion that nuclear heat is expensive heat and that it must be used in efficient power-plant systems in order to make its use attractive. We feel that the first area of extensive application will be in plants of moderate output, say, up to 30,000 kw or the equivalent in shaft horsepower. The closed-cycle gas-turbine nuclear power plant offers the possibility of minimum space and volume requirements with excellent efficiency.

## Open-Cycle Gas Turbines[3]

The open-cycle gas turbine in reactor power systems is worthy of consideration because it is a system with many potential applications, in both the conventional and exotic areas of nuclear power. By conventional is meant those areas where competition with fossil fuels is strictly on a dollar basis as in central-station power. By exotic is meant those applications where the extreme compactness of nuclear fuels is exploited, to do jobs not otherwise possible.

It has been well established by now that the gas-turbine power plant must derive its energy from a sufficiently high-temperature reactor system that we must talk either of gas-cooled reactors or liquid-metal-cooled reactors. In the case of the closed-cycle gas turbine, the best gas for the reactor is not the best gas for the engine, and so a binary loop makes a good deal of sense. The use of a single loop filled with a compromise gas, that is, a mixture of helium and heavier gases, also makes a good deal of sense. We must therefore consider the full range of possibilities with closed cycles for each individual application that arises.

But what is the field of choice in reactors for open-cycle systems? Again, binary systems using gas-cooled or liquid-metal-cooled reactors are possible, and so again is a single gas-filled loop (in this case the gas is air). But the open-cycle reactor system is small and light and its chief stock in trade is its relative simplicity. Its application at low power levels is particularly promising.

[3] Condensed from "The Open Cycle Gas Turbine in Reactor Power Systems," by C. H. Fox. The Martin Co., Baltimore, Md.

To complicate this system with binary loops is to throw away its prime value, and for this reason the air-cooled reactor looks very desirable. It should be developed—it should be made a reality, and it can be.

In the nuclear field, particularly at low power levels, capital costs are of primary importance. The most optimistic cost estimates for a state-of-the-art reactor system seem to run over $1000 per kw for a plant in the 1000 to 2000-kw range. Capital costs become even more pronounced below 1000 kw. When considering perhaps $2000 or $3000 per kw for a reactor power plant, which plant will operate at low power levels, what does thermal efficiency really mean in the over-all plant economics? The answer is, very little indeed. The design emphasis must logically fall upon capital costs. For this reason the open-cycle gas-turbine reactor system is best considered in only one form; the single-loop, air-cooled-reactor power plant.

### Open-Cycle Applications

Let us now consider the conditions which determine the applicability of the open cycle. The obvious applications are those where the specific advantages of open cycle are of primary importance. Thus the use of air as reactor coolant, working fluid, and auxiliary cooling medium permits use in areas where cooling water is not available. The presence of water is assumed in most discussions of the closed cycle.

Another valuable characteristic of the open cycle is availability of coolant. No special gases need to be carried along with the power unit, and a small leak cannot shut down the plant.

The previously mentioned advantage of relative simplicity of the open-cycle system is important for two reasons: (1) The cost of the power equipment is reduced somewhat below that of the closed cycle. (2) And most important, since the nonfailure probability of a system is the product of the nonfailure probabilities of its components, the simpler system is more reliable.

These then are the primary advantages of open-cycle systems that determine its applicability in power ranges where the closed cycle can compete. In the very low power range, below 1000 kw, the closed cycle is entirely out of the running. Several of the usually cited advantages of the closed cycle actually become disadvantages. The higher gas density of the pressurized closed-cycle system results in rotating equipment so small that rotational speeds are prohibitive if reasonably long life is desired. This is a power region where the development costs for open-cycle gas turbines are much less than for closed-cycle equipment. Since the reactor power plant is most likely to require longer equipment life than most current applications of gas turbines, it actually appears much more desirable to down-rate existing engines than to develop entirely new designs.

Thus we see that there is real application for the open-cycle gas turbine in nuclear power systems, specifically at low power levels. How low depends on how important it is to operate without cooling water, how remote and difficult to maintain the plant will be, and so on. In other words, the specific application determines the crossover power level at which the closed cycle becomes preferable. However, assuming water to be available, the crossover point appears to be over 1000 kw.

### Type of Reactor

So far, we have not considered the reactor itself beyond the point of naming the reactor coolant. There are many potential reactors for use with either open or closed-cycle gas-turbine systems. A few of these have been mentioned. The most interesting are, of course, the newest, and beyond those lie the systems which seem possible but are yet to be tried.

There can be thermal, intermediate, or fast reactors. We can speak of reactors fueled with U-233, U-235, or plutonium. There is a variety of thermal and intermediate reactor moderators available, and in addition, fast reactors requiring no moderator at all ultimately may offer the smallest simplest system for very low power levels. The LMFR system under development at BNL offers the advantages of a homogeneous fuel and permits the high temperatures needed for gas-turbine systems. Sodium, NaK, and lead-bismuth-cooled reactors can offer reasonably high powers with reasonably small size. Gas-cooled reactors will, of course, offer the greatest simplicity in the power equipment.

It is not unreasonable to say that in the next 10 years the results of applied research in the nuclear-reactor field will make available a number of heat sources excellently suited to gas-turbine systems. It is logical that the air-cooled reactor will take its place as the most promising companion for the open-cycle turbine system, just as the gas-cooled reactor is the logical companion for the closed-cycle system.

## *Small Gas-Turbine Reactor Plants*[4]

THE 1953 ASME Report on Oil and Gas Engine Power Cost includes information on 137 oil and gas-engine generating plants. The output range of these plants is 375 to 23,000 bhp. In order to evaluate the role of reactor plants in this power-generation field preliminary design studies have been made of 200-kw and 2000-kw gas-turbine reactor plants.

These design studies have been based on tested turbomachinery. The gas-cooled reactors which replace the combustor or air heater in the gas-turbine system employ solid moderators and Army package reactor-type stainless-steel fuel elements.

For the 200-kw plant an open-cycle gas turbine is selected over the closed cycle because of its adaptability to plants of small output, the elimination of heat exchangers, and the general availability of small industrial open-cycle gas turbines.

The Jupiter T-520 developed by Solar Aircraft Company was selected for this application. This open-cycle unit is very light (total installed weight 854 lb), uses a single combustor, and is designed for shipboard generator sets. The T-520 when operating at design speed of 20,000 rpm and a compressor air-inlet tempera-

[4] Condensed from "Small Gas-Turbine Reactor Plants," by J. G. Gallagher, Alco Products, Inc., Schenectady, N. Y. Assoc. Mem. ASME.

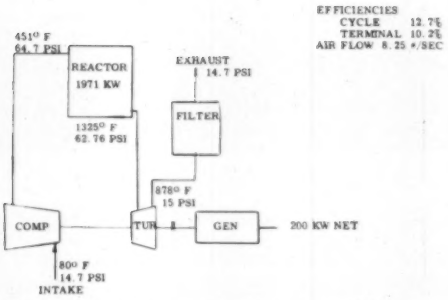


**Fig. 4 Flow diagram of 200-kw gas-turbine reactor power plant**

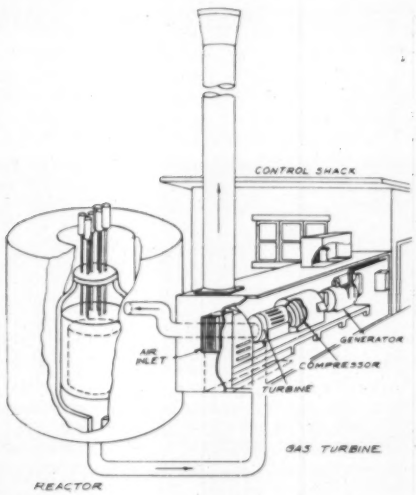


**Fig. 5 Preliminary layout of turbomachinery and reactor for 200-kw power plant**

ture of 75 F can produce 400 bhp with a 1325 F turbine-inlet temperature.

Replacing the single combustor of the T-520 with a gas-cooled reactor has the effect of reducing the expansion ratio across the turbine because of the pressure drop across the reactor and the back pressure from the filter and exhaust ducting.

The variation of reactor power and cycle efficiency was investigated for a range of turbine-inlet temperatures with a 5 per cent $\Delta P/P$ system pressure drop. The results indicate that a 250-kw brake or 200-kw net output should be possible with a 1325 F turbine inlet without pushing the fuel-element temperature above 1500 F, since the reactor power is only 2 mw. The flow diagram is shown in Fig. 4.

A preliminary layout of turbomachinery and reactor is shown in Fig. 5. The basic simplicity of the plant is clearly illustrated.

***Nuclear Design.*** The nuclear design is characterized by a square lattice containing a single fuel element per cell. No attempt is made to flatten the power by nuclear design. The reactor configuration is that of a right cylinder reflected on all sides.

***Thermal Design.*** The object of the thermal design is to get the heat out with the minimum fuel-element temperature and pressure drop. It has been shown that by tapering the flow passage in an air heater (or reactor) the surface temperature may be kept constant and the minimum pressure drop incurred. The hydraulic diameter of the air passage is varied radially to obtain the same temperature rise in each cell. In order to obtain the minimum pressure drop and constant surface temperature the flow passage is tapered axially. This results in an increased heat-transfer coefficient at the outlet which offsets the rising air temperature. The general arrangement of the reactor is shown in Fig. 6.

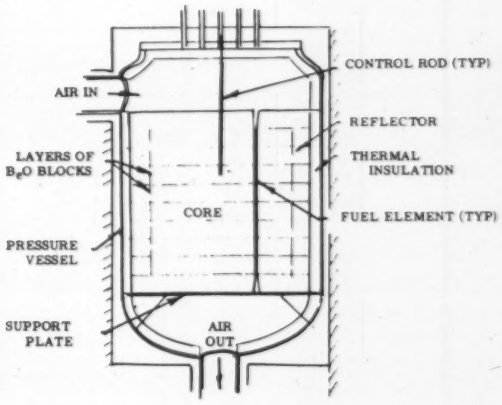


**Fig. 6 General arrangement of 200-kw gas-turbine power-plant reactor**

**Table 2 Reactor Characteristics of 200-Kw Plant**

| | |
|---|---|
| **Core** | |
| Thermal output, kw | 1970 |
| Diameter and length, ft | 4 |
| Reflector thickness, ft | 0.5 |
| Initial loading, Kg $U^{235}$ | ~25 |
| Core life, mw-yr | 4 |
| Life at full power, hr | 8000 |
| Lattice spacing (square), in. | 1.5 |
| Number of cells (and fuel elements) | 800 |
| Temperature coefficient, $\Delta K$/deg F | Negative |
| Volume per cent materials in core, at mid-point | |
| BeO | 91 |
| Metal | 2 |
| Void (air) | 7 |
| **Fuel Element** | |
| Two fuel bearing plates brazed to two tapered plates at top and bottom edge | |
| **Moderator** | |
| Hot-pressed BeO blocks | |
| Density, gm/cc | 2.76 |
| Number of core blocks (includes end reflector) | 8000 |
| **Heat-Transfer Characteristics** | |
| Weight flow of air, c cell, lb per sec | 0.017 |
| Weight flow of air, average, lb per sec | 0.0103 |
| Peak-to-average power, over-all | 2.216/1 |

***Mechanical Design.*** The flow path through the reactor is downward in all cases to avoid contact of the hot gases with the control rods and seals. An attempt has been made to keep the moderator block design as simple as possible. The high-temperature element is subjected to the very minimum mechanical loads.

The reactor characteristics of the 200-kw plant are tabulated in Table 2.

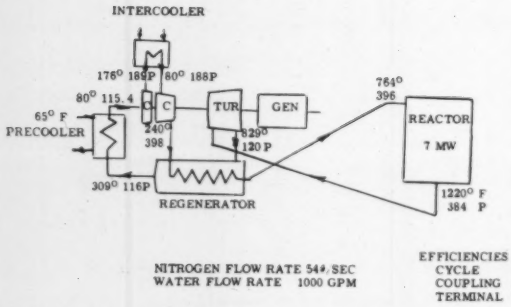


**Fig. 7 2000-kw gas-turbine-reactor-power-plant flow diagram**

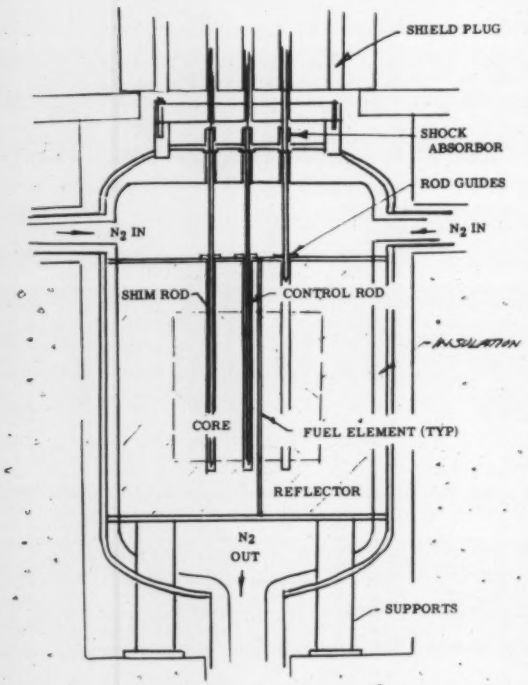


**Fig. 8 General arrangement of graphite reactor for commercial power plant**

## The 2000-Kw Plant

Fuel costs for conventional oil and gas-engine plants are about 7 mills per kwhr. If the small nuclear plant is to be competitive, fuel burn-up costs must be low, about 4 mills per kwhr, since fuel-element fabrication cost may run from 1 to 2 mills. If enriched uranium costs $20 per gram, only a plant with thermal efficiency of 27.5 per cent or greater can meet this fuel burn-up cost. A review of the possible types of small reactor plants indicates that only a liquid-metal reactor (LMR) or a high-temperature gas-cooled reactor operating with a high-temperature high-pressure steam system or a closed-cycle gas-turbine plant can meet this thermal efficiency. The liquid-metal reactor faces difficult corrosion problems for long-term operation. Small high-temperature, high-pressure steam plants do not appear too practical. This leaves only the gas-cooled reactor in a closed-cycle gas-turbine plant.

The designer of a small closed-cycle gas-turbine plant has only a very limited selection of turbomachinery available. The Escher Wyss Tuco 52 Unit, rated at 2500 kw with 1300 F turbine-inlet temperature, is selected for this design study. The requirement of high fuel-element burn-up indicates that the plant should be operated at 1220 F turbine-inlet temperature in order that the fuel-element surface temperature be below 1500 F.

The Tuco-52 machines have been built and run by Escher Wyss, Ltd., with air as the working fluid and a combustion-fired gas heater. The nuclear power plant may be run in an indirectly cooled arrangement using air as the working fluid in the turbine and heating the air in a heat exchanger which communicates with the reactor through an auxiliary fluid circuit. An alternative arrangement is to cool the reactor directly with the working fluid, in this case nitrogen. The use of nitrogen in the direct closed cycle permits a lower reactor temperature and eases the moderator material problem; it is selected for this design study.

The power-plant flow diagram is shown in Fig. 7.

## Reactor

*Fuel Element.* The fuel element for the 2000-kw plant is a stainless-steel $UO_2$ plate element of the APPR type. The high-temperature high burn-up properties of this element as well as possible effects of nitriding remain to be investigated.

*Moderator.* In the closed-cycle plant, using nitrogen as coolant, no attempt is made to isolate the graphite moderator from the coolant; however, the nitrogen must be kept oxygen-free. High-density graphite is proposed for the core of this design. The reflector would be reactor grade AGOT of density 1.71 gm/cc.

The chief concern in the graphite-moderated reactor is the corrosion rate and oxidation (from impurities) of the high-density core graphite at elevated temperatures with the high-temperature high-velocity nitrogen Tests with helium upon a machined graphite surface at 2000 C revealed that once the loosely bound particles smeared into the surface during the machining operation were blown free, no further erosion was apparent provided the helium was free of oxygen and entrained particles. It is well to bear in mind that radiation has a pronounced effect on certain reaction rates.

At the moderator temperature ($>$ 1000 F) expected in all the designs there should be no important dimensional changes because of radiation damage.

*Nuclear Design.* The reactor is characterized by a square lattice containing one plate element per cell.

**Table 3 Reactor Characteristics of 2000-Kw Plant**

| | |
|---|---|
| **Nuclear Characteristics** | |
| Thermal output, mw | 7.0 |
| Diameter and height of core, ft | 4.1 |
| Reflector thickness, ft | 1.45 |
| Outside diameter of reactor, ft | 7.0 |
| Outside diameter of pressure shell, ft | 8.0 |
| Initial loading, kg | <25 |
| Lattice spacing (square), in. | 2.5 |
| Number of cells (and fuel elements) in core | 302 |
| Fuel element | |
| Materials in cell, vol. per cent | |
| Graphite | 94.5 |
| Nitrogen | 4.8 |
| Stainless steel | 0.7 |
| $UO_2$ | 0.17 |

The nitrogen coolant flows on both sides of the plate element. The reactor configuration is a right cylinder reflected on all sides. No attempt is made to flatten the power generation by nuclear design.

***Thermal Design.*** The same approach used in the small plant is followed. In this cell layout the flow passage is varied by changing the depth of the passage milled in the graphite so more flexibility is possible compared to the design with the coolant flowing inside a square tube.

***Mechanical Design.*** The general arrangement of the graphite reactor for the commercial plant is seen in Fig. 8. The reactor characteristics are given in Table 3.

### A Prototype the Next Step

The reactors proposed are felt to offer the most direct path to the small gas-turbine reactor plant.

There are still some very important assumptions in regard to the materials that must be verified. Materials are the key to these high-temperature reactors.

With the successful operation of a stationary prototype, one can envision either the open or closed-cycle plant mounted on special highway vehicles for portability. The closed-cycle unit might be adapted for marine use.

## Large Gas-Turbine Reactor Plants[5]

THE characteristics of a gas-turbine nuclear power plant with an output on the order of 15 mw will be considered together with some discussion of the maximum-size plant which is technically and economically feasible. The material for this presentation is the result of a preliminary study by the author's company on some of the problems inherent in gas-turbine reactor system design. The proposed application of the 15-mw plant is for small cities or industrial areas in the United States, for foreign and geographically remote areas, and for ship propulsion. The use of both open and closed-cycle machinery has been considered.

### Comparison of Systems

For the plant under consideration the advantages of an open-cycle gas-turbine reactor power plant are (1) no heat sink required; and (2) lower cost.

The advantages of a closed-cycle gas-turbine reactor power plant are (1) elimination of reactor oxidation; (2) more efficient part-load operation; (3) elimination of radioargon; (4) better heat transfer (pressure and gas selection); (5) containment is feasible.

Clearly, since the exhaust heat is dumped directly to the atmosphere, no heat sink is required for an open-cycle reactor. This is of substantial importance in regions where neither cooling water nor low-temperature air is available. Since the heat sink is omitted, the over-all cost of the open-cycle plant will probably be less. On the other hand, since chemically inert gas can be used as the working fluid in a closed cycle, moderator and fuel-element oxidation are eliminated. By operation at reduced pressure, part-load efficiency may be maintained. Since the gas through the reactor is not exhausted to the atmosphere, there is no problem of activation of argon 40. However, the activation of the closed-cycle fluid must be considered. As a very general rule, it will be possible to achieve better heat transfer for a given pressure in closed-cycle machinery since the pressure is not limited by the pressure ratio of the turbine and since the gas coolant used may be selected for its good heat transfer to pumping power ratio. Since a closed-cycle plant does not exhaust air directly to the atmosphere, it is possible to use a type of construction which would contain the activity in the event of a nuclear incident. While it would probably be possible to provide containment for an open-cycle plant, it would not be as easy or as foolproof.

In consideration of these and other circumstances, it was decided to limit our initial study to closed-cycle plants since the variety of possible applications would otherwise prevent a completely satisfactory solution to the argon-contamination problem. It should be emphasized that open-cycle plants might be more desirable than closed-cycle plants for specific applications. But for the classes of applications considered here, we felt the closed-cycle plant to be superior.

***Thermal Heterogeneous Reactors.*** For our first analysis of gas-turbine reactors we have limited the investigation to thermal heterogeneous reactors with a solid moder-

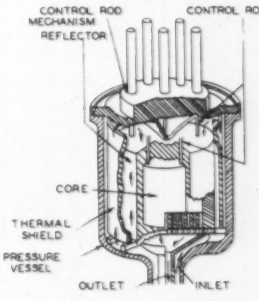


Fig. 9 Arrangement of proposed gas-turbine reactor

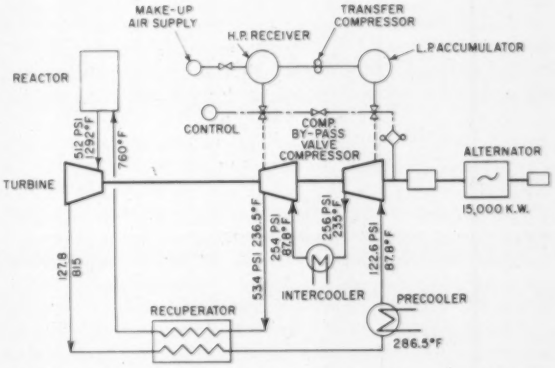


Fig. 10 Flow diagram of closed-cycle power plant with flow of 296 lb per sec

[5] Condensed from "Nuclear Reactors for Large Gas Turbines," by T. Jarvis, Ford Instrument Company, Division of Sperry Rand Corporation, Long Island, N. Y.

ator. Since part of the reactor-core volume must be moderator, not all of the reactor-core cross-sectional area is available for flow area.

Based on relatively crude nuclear calculations, a free-flow area of 20 per cent of the total area will maintain relatively good neutron economy. For these conditions, power densities in the order of 4000–5000 kw per cu ft are probably attainable. Thus it should be possible to design power reactors of reasonable size.

***Arrangement of Reactor.*** A possible arrangement of the proposed reactor is shown in Fig. 9. It is planned to use coaxial piping for the connection between the reactor and turbocompressor set. The relatively cool reactor-inlet gas will flow in the outer annulus, with the hot reactor-outlet gas flowing down the center pipe. By this means, the pressure differential across the high-temperature pipe will be that of the pressure drop across the reactor rather than the maximum system pressure. A thinner wall pipe can therefore be used for this application.

An extension of this principle is to be applied to the reactor pressure vessel. The reactor inlet gas flows upward around the inside of the pressure vessel and then down through the core and into the inner pipe. This method of handling gas flow will result in a substantial reduction in pressure-vessel thickness.

The core is composed of close-packed elements and is about 5 ft diam, surrounded by 1 ft of reflector. A 1-in. steel thermal shield helps protect the vessel. The over-all size of the vessel is about 9 ft and its height is about 13 ft including the control-rod mechanisms.

The control-rod assemblies are mounted on a single pressure-vessel lid. All the control-rod assemblies are removed with the lid and can then be set aside to cool and later repaired if desired. The unloading machine would then fit exactly into the pressure-vessel lid opening and fuel rods could be removed automatically. Only one seal-welded or gasketed opening in the pressure vessel would be required.

***Working Fluid.*** The selection of the gas to be used as working fluid could be based on thermodynamic, chemical, nuclear, and state-of-the-art considerations. A first-round elimination left carbon dioxide, helium, and nitrogen. Since the state of the nitrogen art is fairly well established and the nuclear properties not too bad, nitrogen was chosen as the working fluid in our first-round design study. We plan to study the other gases as time permits.

***Moderator.*** The selection of the moderator to be used is based on mechanical, chemical, nuclear, and state-of-the-art considerations. Our first-round elimination here leaves graphite and beryllium oxide. We cannot decide between the two on the basis of available information and we suspect that both eventually may be used. The graphite looks as though it will result in a larger and cheaper reactor and thus beryllium oxide may be used wherever weight or size is at a premium. All calculations to date have been done on both materials in parallel.

***Fuel Element.*** The fuel-element material will be either metallic or cermet-ceramic. Progress in development of ceramic fuel elements is not as advanced as in metal elements, but it is reasonably certain that ceramic elements, if feasible, will be more desirable.

***Flow Diagram.*** A flow sheet of the power plant is shown in Fig. 10. The working fluid is compressed from 8.3 to 16.6 atm in the first compressor with after-cooler and is further compressed to 36.3 atm in a second compressor, which is mounted in the same casing as the turbine. The compressed fluid is then heated, first in the circuit recuperator and then by heat from the reactor.

The closed-cycle fluid expands in the turbine, which is mechanically coupled to the compressor and to the generator by a speed-reduction gear. The expanded fluid gives up heat in the recuperator and returns to the compressor inlet through a precooler. The pressure figures correspond to the full rated load of 15,000 kw. Over-all cycle efficiency at the generator terminals is about 34 per cent.

***Cost Estimates.*** All of the cost estimates made to date on this type of plant is of necessity extremely rough and very sensitive to the precise state of mind (optimistic or pessimistic) of the estimator. It is not likely that this state of affairs will be changed in the immediate future since much development remains to be done. In physicists' language, estimates for this sort of plant might be:

Installed cost . . . . . $250 ± $75 per kw
Power cost . . . . . 12 ± 3 mils per kwhr at 80 per cent load factor

## What Size Plant Is Feasible?

We can most significantly consider the feasibility of a really large-size plant by trying to design one. We chose a 240-mw electrical output plant because it was large and gas-turbine data could be extrapolated easily. We decided to limit pressure-vessel size to that which is relatively easily transportable. We assume that 13 ft diam will be allowable and that 1000-psi helium closed-cycle gas-turbine machinery will be available.

Preliminary heat-transfer calculations indicate that adequate heat-transfer coefficients can be achieved. Resulting hydraulic diameters are reasonable, so that straightforward flat-plate or tubular fuel elements will be adequate. In view of the large reactor size, many control elements and actuators will be required. A 240-mw plant will be feasible technically if a 15-mw plant is feasible. No cost estimates have been yet prepared on this plant, but it appears likely that this plant may represent a rather interesting approach economicswise to competitive central-station power.

It may be possible to reduce the installed cost per kilowatt very sharply, thus reducing fixed charges and allow a somewhat higher fuel-operating cost, while still keeping a competitive over-all cost.

It should be emphasized that there are numerous outstanding technical problems to be solved before any closed-cycle gas-turbine reactor power plant can be constructed and operated. It is our opinion that the greatest area of uncertainty is in the fuel elements. The maximum operating temperatures, mechanical stress, thermal stress, and radiation damage at elevated temperatures must be studied theoretically and experimentally. Diffusion of fission products through fuel-element walls must be determined under simulated operating conditions. Mechanical and reactivity limitations of fuel burn-up must be determined before maximum burn-up and hence a realistic operating cost can be determined. It is probable that moderator and coolants chosen will be compatible at the expected radiation levels but an experimental check would be desirable. Over-all system stability and safety should be checked. These problems should not be underestimated, but present indications are that they surely can be solved.

# The Reactor Safeguards Committee . . . .

## *Its purpose, scope of activities in nuclear-power industry, and operating procedures*

**By C. Rogers McCullough**

Monsanto Chemical Company, St. Louis, Mo.

In the rash of enthusiasm in the disclosure of atomic energy to the public in 1945, there were many proposals for the building of reactors by partially informed people. In 1949 the Reactor Safeguards Committee was formed to look over existing and proposed reactors to make sure that they did not constitute an unreasonable hazard to the public and in so far as possible to assure that a serious accident would not occur to set back the atomic-energy industry. The Reactor Safeguards Committee reviewed all reactors and significant changes thereof. It was charged with the responsibility of advising with regard to government properties, the protection of the employees, and the protection of the public in matters pertaining to nuclear reactors. Prior to the Atomic Energy Act of 1954, all reactors were owned by the Atomic Energy Commission with the one exception of the small water boiler at North Carolina State College.

This act brought changes to the entire industry. Now it is possible for corporations to own reactors. There has been a tremendous upsurge in the number of reactors proposed for research, medical purposes, power, and various military uses. The Advisory Committee on Reactor Safeguards, which was formed by merger of the former Reactor Safeguards Committee and the Industrial Committee on Reactor Location Problems, was already functioning prior to the Atomic Energy Act of 1954 and is continuing as an advisory agency to the Atomic Energy Commission in this field of reactor hazards.

It is worth while, therefore, to examine and discuss the purpose, scope, and operation of this committee to be sure that it is properly integrated in the atomic-energy program as it exists, and will exist in the foreseeable future.

The problem of evaluating the hazards of nuclear reactors is an extremely important and difficult one. In the eyes of the members of this committee, it is one of the major problems facing the whole atomic-energy industry.

### Purpose and Scope of Committee

It should be made clear that the Advisory Committee on Reactor Safeguards performs an advisory staff function to the general manager of the Atomic Energy Commission. It can only recommend; it has no power of decision. The general manager of the Atomic Energy Commission depends upon this committee to study reactors from the point of view of possible hazards to employees at the reactor and to the public, and to make appropriate recommendations. The committee hopes that its activities will stimulate improved reactor designs which will permit rapid progress without unreasonable hazard.

Since the Advisory Committee on Reactor Safeguards is responsible for evaluating the hazards of all reactors, it is necessary to review all aspects of the reactors and their locations pertinent to this problem.

***Hazardous Elements.*** To be specific, some of the items examined are as follows: The reactor core and its nuclear properties, including fuel-element construction, core configuration, coolant flow, temperature distributions, transient effects, and so on; the control and safety system including kind of control rods and location, their interaction with each other and the fuel elements, their rate of response, the primary sensing elements, and all the interrelations of the reactor and the power system if a power reactor, or with experiments if a research reactor. A review is made of the tank or pressure vessel for the reactor.

The reactor coolant system is of the utmost importance. In many cases the coolant is also the moderator and so changes in its properties directly affect the nuclear reaction. In any case, reactors must be cooled to avoid melting or vaporization even after shutdown of the nuclear reaction, so the kind of pumping system, power supply, capacity, effect of corrosion, and general reliability are pertinent.

***Safety Measures.*** It is attempted of course, to make the reactor as foolproof and automatic as possible. Realistically, one must depend upon a combination of mechanical devices, interlocks and safeties, operating procedure and supervision. It is necessary that there be well-conceived and carefully carried out procedures for start-up, normal operation, shutdown, unloading, and loading of a reactor. A reactor proposal should specify these procedures in some detail so that their adequacy may be judged. The operating procedure also should cover abnormal operation with the action to be taken in the case of various foreseeable abnormal situations.

***"Containment."*** While it is highly desirable to have a reactor design of inherent stability and incapable of sustaining an accident of any serious nature, it is the committee's view that such a machine does not exist. Because of the great toxicity of fission products, a major accident could have very serious consequences to the public and, accordingly, it is felt that the reactors of any significant power, say, above 1 mw, that are located in populated areas, must be surrounded by some sort of tight shell, which might be a steel sphere or a specially tight building, so that an accident of any nature will not jeopardize the lives or property of the public to a significant extent. This is called containment. This does not seem to be an excessive economic burden on the atomic-energy industry. Estimates for commercial-size nuclear power stations appear to place this containment burden at less than 10 per cent of the total capital.

Contributed by the Nuclear Engineering Division of The American Society of Mechanical Engineers and presented at the Nuclear Engineering and Science Congress, Cleveland, Ohio, December 12, 1956. Condensed.

***Reactor Location.*** The location of a reactor is also an important factor. Theoretically, if a reactor plant were surrounded by a shell which would be guaranteed not to leak and which was provided with adequate shielding there would be no need to worry about how close to this container people lived and worked. Practically, however, it is cheaper to buy sufficient land so that in the event of serious accident inside the container, the public would not be unreasonably exposed to the gamma rays from the shell. In studying location and the possible effects of a bad accident, one must consider the meteorology, hydrology, geology, and seismology of the site.

***Hazards Summary Report.*** All of the data which have been discussed may be summarized as design, operation, supervision, containment, and location. All of this information must be contained in a "Hazards Summary Report." In addition, this report must contain a description of all significant creditable accidents, the devices and procedures to prevent or alleviate them, and an analysis of the events and consequences. This part of the report constitutes a positive record of accident prevention. The remaining sections of the report are more or less unique to the reactor business. They are part of the considerations of the Advisory Committee on Reactor Safeguards because, as of now, the committee sees pertinence in all of the data requested.

***Reactor Operation.*** At the present time, all new reactors and significant changes in existing reactors are reviewed by the Advisory Committee on Reactor Safeguards. This includes critical experiments. This has been an increasingly heavy load and steps are being taken to carry it more properly. A full-time staff is being set up by the Atomic Energy Commission to do the detailed evaluation of each reactor proposal. To understand better how reactor-hazard evaluation actually works, an example will be followed through. This example will be for a privately owned reactor.

***Licensing.*** The owner of the reactor applies for a facility license. The application for a license should be accompanied by a Hazards Summary Report. If this report were complete, there would be no need of any additional information for judging how the public health and safety might be affected. The report would be reviewed by the Reactor Hazard Evaluation Staff and referred to the Advisory Committee on Reactor Safeguards. The committee would put this particular reactor proposal on its agenda for the next meeting, 30 days or more in the future. The committee meets every two months or more frequently if required, averaging about nine times a year. At the meeting, the full proposal would be reviewed with the applicant describing the salient points of the proposal and the means taken in protecting the public. The committee then writes its recommendations to the general manager of the Atomic Energy Commission.

***Lack of Information.*** Experience so far has shown that the data submitted with the application for a license have been insufficient to judge the possible hazards to the public associated with the reactor. In many cases the application has been submitted before the reactor and its facilities have been designed. In fact there are cases where the critical experiments determining the nuclear characteristics of the reactor have not even been performed. When one realizes that no commercial-size nuclear-reactor power plant has yet been designed in this country, one should not be surprised at this situation. In other words, this is a brand-new situation that we are trying to resolve.

***Advisory Subcommittees.*** Since no two reactors are alike at this stage of the technology, it is not possible to write a set of standards. The only practical way is for the applicant to go through the general headings already given and patiently and carefully examine each pertinent point. To help out in this situation, subcommittees have been appointed to work with the applicants for major nuclear-power-plant licenses. These subcommittees, of about three, meet with the designers as required and discuss the problems on an informal basis. A small group like this, meeting for a full day, can cover a great deal of ground. From these meetings the applicant can determine the material to put in the Hazards Summary Report. The subcommittee reports to the full committee and thus keeps it currently informed as to the status of the proposal. Out of this joint effort will come standards to judge future reactors.

***Need for Standards.*** At the same time it is necessary to start independently to write tentative standards for reactor design. The committee has initiated this task and it is one of the primary objectives of the Reactor Hazard Evaluation Staff. However, this also should be the concern of the professional engineering societies. The Engineers Joint Council has appointed a committee to study the matter. The ASME Pressure Vessel Code Committee is working on one phase of the problem. However, the problem is urgent. Reactors require almost every conceivable skill so a much broader coverage is needed. It will be difficult to develop suitable standards and this is a good reason for starting now.

When standards are available it is planned that they will be reviewed by the Advisory Committee on Reactor Safeguards and approved by the general manager. The Reactor Hazards Evaluation Staff will then be able to gage reactors against these standards. This will occur first for small reactors, critical experiments, and the like. It is planned that for some time the large reactors will be reviewed by the Advisory Committee on Reactor Safeguards. Practically, however, it appears the committee will carry the bulk of the load in the immediate future.

## A New Approach

From the foregoing it can be seen that the Advisory Committee on Reactor Safeguards together with the Reactor Hazard Evaluation Staff being established by the Atomic Energy Commission is attempting a new approach for a budding industry. An effort is being made to prejudge the possible hazards which may be encountered in the operation of nuclear reactors by the proper application of already accepted industrial standards and engineering judgment to assure that these machines will not constitute an unreasonable hazard to their employees or the public.

While the Reactor Hazard Evaluation Staff is being assembled and tentative standards written, the Advisory Committee on Reactor Safeguards plans to take care of the presently proposed large nuclear-power reactors by subcommittees to assist the full committee in the evaluation. It is believed that by working together the designers, the Reactor Hazard Evaluation Staff, and the Advisory Committee on Reactor Safeguards not only will help expedite the construction of nuclear-power reactors but will evolve a set of tentative standards during the evaluation of these first few machines.

# Properties of Steam at High Pressures

## —An Interim Steam Table

By R. C. Spencer,[1] C. A. Meyer,[2] and R. D. Baird[3]

During the past years the steam conditions considered for central-station steam generation and chemical-process plants have increased above the limits of experimental investigations and lately above the extrapolations contained in currently published steam tables. The table described in this paper is a reasonable and consistent extension of the Keenan and Keyes steam tables into the region of 5500–10,000 psia and 32–1600 F and will be useful in power-systems calculations until tables developed by the ASME Steam Properties Research Project are available.

DURING the past years the steam conditions considered for central-station steam power generation and chemical-process plants have increased above the limits of experimental investigations and lately above the extrapolations contained in currently published steam tables. In order to fill the need for accurate high-pressure and high-temperature steam properties, The American Society of Mechanical Engineers through a Technical and a Research Committee is undertaking as part of an international program the task of directing and co-ordinating the 4 to 6 years of experimental work leading to an authoritative steam table to 15,000 psia and 1500 F. This program is well described in the ASME publication "Steam Properties Research" (1).[4]

However, during the 4 to 6-year period required to develop the authoritative table, it would be desirable to have an industry-wide accepted table covering the high-pressure region which would be essentially correct from an engineering viewpoint. With this end in mind the ASME Power Division formed a Subcommittee for the express purpose of preparing such an interim steam table.

The Subcommittee delineated the range of this interim steam table as 5500 to 10,000 psia and 32 to 1600 F. The Subcommittee also stated that the table should be prepared in the most expeditious manner possible by making use of any presently available tables and should, if possible, join smoothly some currently published table for the lower-pressure regions. The reason for establishing data in the low-temperature, high-pressure region is primarily because of the increased importance of boiler-feed-pump work on steam-cycle efficiency as pressure is increased in central-station power plants. This paper contains a description of what has been done, and the resulting table.

The authors wish to emphasize that the interim steam table presented herein is not based upon any new data, and probably will be proved to be somewhat in error when the experimental results are obtained from the ASME Steam Properties Research Project and other new work. The sole purpose of this interim table is to provide a consistent and reasonable extrapolation of current tables that will be useful in power-system calculations until better data are available.

### Development of the Table

The area covered by the interim steam table was divided into three regions as shown in Fig. 1, and the development of the table for each region is fully described in the following sections.

A review of currently available high-pressure tables indicated that the table developed by the United Aircraft Corporation (2) would serve in the high temperature-pressure region *A*, Fig. 1. There appeared to be no available table in the low temperature-high pressure region and it was therefore necessary to develop a new table for this region. Further investigation pointed out that problems would be encountered in the middle temperature region *C*, of 640–960 F owing to unusual inflections in the enthalpy data. Therefore this middle region was treated separately from the low-temperature region *B* in developing the new data.

*Region A—960 to 1600 F.* The United Aircraft Corporation (2) tables, which were based upon the experimental results of Kennedy, extended from 840 to 1600 F and the authors originally intended to use them to the lower-temperature level. However, further investigation in the 840 to 960 F region indicated that the United Aircraft Corporation isobars of an enthalpy-temperature diagram had double-inflection points. Since the slope of these isobars is directly proportional to the specific heat, this double inflection results in the specific-heat curve having a double maximum within a relatively small temperature range. A brief discussion of this phenomenon is contained in reference (3). The United Aircraft Corporation tables were not used below the somewhat arbitrarily selected temperature of 960 F because it does not seem probable that water substance actually would have this double-inflection characteristic.

To satisfy the criteria that the interim table should join a currently published steam table in a smooth manner the authors elected to make the interim table consistent in level, and join smoothly with the Keenan and Keyes (4) tables along the 5500 psia line. Since the

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[4] Numbers in parentheses refer to the Bibliography at the end of the paper.

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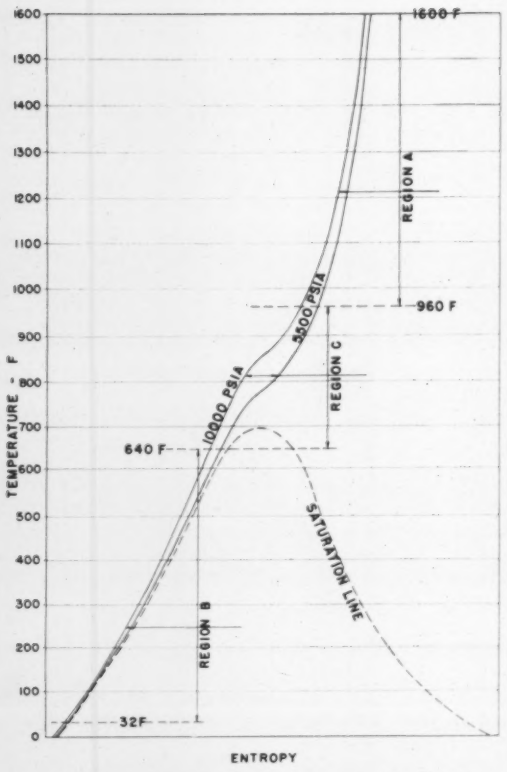


**Fig. 1 Temperature-entropy diagram showing area covered by the interim Steam Tables (not to scale)**

United Aircraft Corporation data and the Keenan and Keyes data differ at 5500 psia it was necessary to change the United Aircraft Corporation level arbitrarily at 5500 psia to that of the Keenan and Keyes data and then fair the correction into the United Aircraft Corporation table. This fairing was done in the 5600 to 5900 psia range.

Also, since the original United Aircraft Corporation table contained data at 100 psia increments (and also at 1300 and 1500 F) it was felt desirable to include these data in the interim table, although a pressure increment of 500 psia was used in the remainder of the table.

The reader is referred to the United Aircraft Corporation (2) report for a comprehensive description of the development of its equation of state and steam table.

***Region B—32 to 640 F.*** In the region below 960 F there was no table available, such as that of the United Aircraft Corporation, which could be adapted for use in the interim steam table. Therefore a table has been developed by the authors using graphical and numerical methods. First, a graphical plot of volume versus pressure and temperature was made for this region using the boundary data of Keenan and Keyes and the high-pressure compressed-liquid data of Amagat (5) as a guide. These volume data were cross-plotted in several ways until a smooth family of volume curves was developed. The volume data were then differentiated and integrated numerically using the methods described in Appendixes *A* through *C* to determine the change in entropy and enthalpy at constant temperature from the 5500 psia level. The usual problems encountered in obtaining smooth results with numerical methods of this type were overcome to the necessary degree by smoothing the basic volume data to the required significant figures. The calculated changes in entropy and enthalpy were added to the Keenan and Keyes 5500 psia values. Since the Keenan and Keyes tables contain values at widely spaced intervals (100 deg F) in this region, it was necessary to interpolate numerically as described in Appendix *D* to obtain values at the desired interval of 10 or 20 deg F. The numerical calculations were carried out on a high-speed electronic computer.

As mentioned under region *A*, the area between approximately 640 and 960 F has a double inflection in the isobars of an enthalpy versus temperature diagram and it was therefore necessary to discard the data above 640 F obtained by the foregoing method.

***Region C—640 to 960 F.*** One way of obtaining a table for this area would have been to redraw the volume curves and repeat the numerical procedure used for Region B. However, since it was desirable to remove the double inflection from the isobars of an enthalpy versus temperature plot, it was decided to draw a family of enthalpy curves arbitrarily that suited the boundary conditions and also gave a smooth family of specific-heat curves. The specific-heat curves derived from the arbitrarily drawn enthalpy curves are shown in Fig. 2. The total area allowable under any one of the isobars in this figure is fixed by the boundary conditions at 640 and 960 F. However, the distribution of the area over this interval is determined by the shape of the enthalpy curves.

With a table of enthalpies it was then possible to determine entropies by using the approximate relationship of

$$(\Delta S)_p = (\Delta H/T_{avg})_p$$

and adding the incremental values to the value at 640 F. Errors attributable to the approximate nature of this calculation were apparent when the entropy calculated by the foregoing method at 960 F was compared with the entropy at 960 F obtained from the United Aircraft Corporation (2) tables. Any difference was then distributed over the interval.

The determination of volumes was at first attempted by an inverse of the procedure used to determine entropy in region *B*. (See Appendix *A*, Equation [2].) However, it was found that the entropy data were not sufficiently smooth to give smooth volumes and therefore the volumes so obtained were used only to determine an approximate level. Once an approximate volume level had been established a family of curves was drawn as shown in Fig. 3 and used to obtain tabular values.

These volumes were checked by calculating enthalpy and entropy with the region *B* method and found to be within the accuracy necessary for the usual engineering calculations and additional effort was not believed to be justified owing to the improbable use of this region of the steam chart.

## Conclusions

Table 1 is a useful and consistent extension of the Keenan and Keyes steam tables into the high-pressure regions that are being investigated for modern steam power and chemical plants. While considerably more effort could have been expended in determining a completely

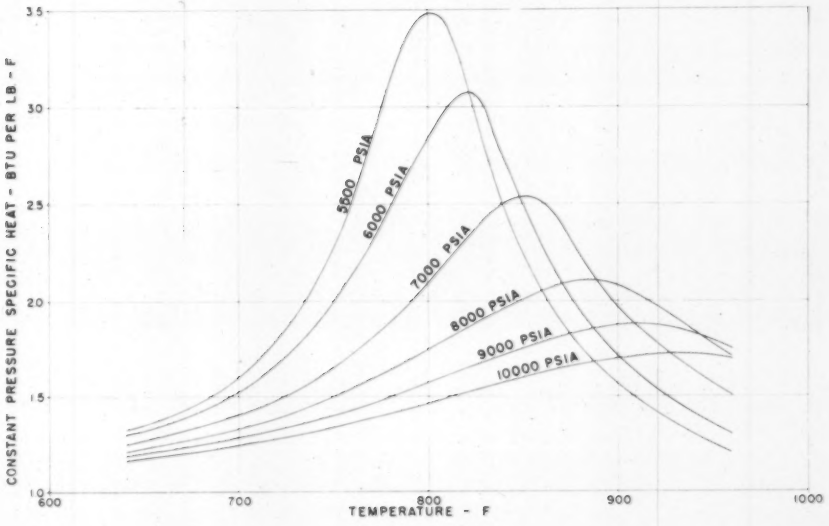


Fig. 2 Constant-pressure specific heats for region C

consistent thermodynamic set of data, it was not felt that the effort was justified, since any table not based upon experimental results will be subject to revision when such data are available.

## Acknowledgments

The authors wish to express their appreciation for the inspiration as well as the guidance of the members of the Subcommittee on Interim Steam Tables; Messrs. P. H. Knowlton, C. C. Franck, and H. D. Emmert; and for the high-temperature data developed by the United Aircraft Corporation (2). Without these excellent tables our task would have been considerably greater. To Mr. H. C. Schnackel of the General Electric Company, Messrs. G. J. Silvestri and W. G. Steltz of Westinghouse Electric Corporation, and Mr. J. S. Barker of the Allis-Chalmers Manufacturing Company goes much of the credit for our success in completing the task in a very short time.

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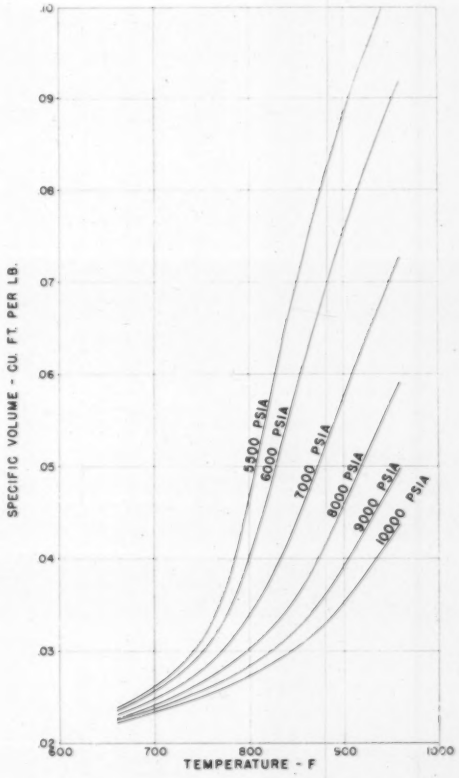


Fig. 3 Specific volumes for region C

## Table 1 Properties of Steam at High Pressures

*Abridged Interim Steam Table*[1]

| Pressure psia | | Temperature — Degrees Fahrenheit | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 32 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 |
| 5500 | v | 0.01573 | 0.01588 | 0.01635 | 0.01708 | 0.01810 | 0.01955 | 0.02177 | 0.0262 | 0.0463 | 0.0880 | 0.1143 | 0.1343 | 0.1516 | 0.1674 | 0.1825 | 0.1968 | 0.2106 |
| | h | 16.18 | 82.38 | 180.5 | 280.0 | 381.8 | 488.3 | 603.9 | 741.3 | 985.0 | 1224.1 | 1349.3 | 1440.8 | 1518.2 | 1588.0 | 1657.0 | 1722.7 | 1788.1 |
| | s | 0.00016 | 0.12609 | 0.28735 | 0.42774 | 0.55352 | 0.67061 | 0.78510 | 0.9090 | 1.1093 | 1.2930 | 1.3821 | 1.4427 | 1.4908 | 1.5306 | 1.5699 | 1.6035 | 1.6369 |
| 6000 | v | 0.01570 | 0.01585 | 0.01633 | 0.01705 | 0.01805 | 0.01947 | 0.02160 | 0.0257 | 0.0402 | 0.0755 | 0.1013 | 0.1207 | 0.1370 | 0.1518 | 0.1660 | 0.1794 | 0.1924 |
| | h | 17.61 | 83.66 | 181.6 | 280.9 | 382.5 | 488.6 | 603.1 | 737.2 | 944.9 | 1192.5 | 1330.5 | 1427.2 | 1507.7 | 1578.4 | 1648.1 | 1715.2 | 1781.8 |
| | s | 0.00010 | 0.12576 | 0.28681 | 0.42695 | 0.55241 | 0.66904 | 0.78249 | 0.9032 | 1.0744 | 1.2642 | 1.3622 | 1.4263 | 1.4765 | 1.5168 | 1.5564 | 1.5908 | 1.6247 |
| 6500 | v | 0.01568 | 0.01583 | 0.01630 | 0.01702 | 0.01801 | 0.01941 | 0.02146 | 0.0252 | 0.0366 | 0.0656 | 0.0906 | 0.1093 | 0.1249 | 0.1390 | 0.1524 | 0.1650 | 0.1771 |
| | h | 19.03 | 84.94 | 182.8 | 281.9 | 383.2 | 489.0 | 602.5 | 733.6 | 918.2 | 1162.8 | 1310.5 | 1413.0 | 1496.8 | 1569.0 | 1639.8 | 1708.0 | 1775.6 |
| | s | 0.00004 | 0.12543 | 0.28627 | 0.42617 | 0.55132 | 0.66752 | 0.78004 | 0.8978 | 1.0502 | 1.2375 | 1.3425 | 1.4104 | 1.4626 | 1.5038 | 1.5441 | 1.5790 | 1.6134 |
| 7000 | v | 0.01566 | 0.01581 | 0.01628 | 0.01699 | 0.01798 | 0.01935 | 0.02133 | 0.0248 | 0.0339 | 0.0577 | 0.0815 | 0.0997 | 0.1147 | 0.1282 | 0.1408 | 0.1528 | 0.1643 |
| | h | 20.45 | 86.22 | 183.9 | 282.9 | 383.9 | 489.4 | 602.0 | 730.4 | 899.4 | 1132.0 | 1290.4 | 1398.7 | 1485.8 | 1559.8 | 1631.7 | 1700.8 | 1769.4 |
| | s | -0.00002 | 0.12510 | 0.28574 | 0.42540 | 0.55024 | 0.66604 | 0.77771 | 0.8930 | 1.0328 | 1.2105 | 1.3233 | 1.3951 | 1.4494 | 1.4916 | 1.5324 | 1.5679 | 1.6027 |
| 7500 | v | 0.01563 | 0.01579 | 0.01626 | 0.01696 | 0.01794 | 0.01930 | 0.02122 | 0.0245 | 0.0319 | 0.0513 | 0.0738 | 0.0915 | 0.1060 | 0.1189 | 0.1310 | 0.1422 | 0.1532 |
| | h | 21.87 | 87.50 | 185.1 | 283.9 | 384.7 | 489.8 | 601.6 | 727.1 | 885.3 | 1101.1 | 1270.4 | 1384.3 | 1474.9 | 1550.7 | 1623.8 | 1693.6 | 1763.2 |
| | s | -0.00008 | 0.12478 | 0.28520 | 0.42464 | 0.54918 | 0.66460 | 0.77545 | 0.8885 | 1.0194 | 1.1842 | 1.3046 | 1.3802 | 1.4366 | 1.4799 | 1.5214 | 1.5573 | 1.5926 |
| 8000 | v | 0.01561 | 0.01577 | 0.01623 | 0.01693 | 0.01790 | 0.01924 | 0.02112 | 0.0242 | 0.0304 | 0.0458 | 0.0673 | 0.0844 | 0.0985 | 0.1108 | 0.1224 | 0.1331 | 0.1435 |
| | h | 23.27 | 88.78 | 186.2 | 284.9 | 385.4 | 490.2 | 601.3 | 724.6 | 875.9 | 1074.4 | 1250.8 | 1369.8 | 1463.9 | 1541.5 | 1616.0 | 1686.7 | 1757.1 |
| | s | -0.00017 | 0.12446 | 0.28467 | 0.42388 | 0.54812 | 0.66317 | 0.77328 | 0.8845 | 1.0099 | 1.1614 | 1.2867 | 1.3657 | 1.4243 | 1.4686 | 1.5109 | 1.5472 | 1.5830 |
| 8500 | v | 0.01558 | 0.01574 | 0.01620 | 0.01689 | 0.01787 | 0.01919 | 0.02103 | 0.0240 | 0.0293 | 0.0420 | 0.0617 | 0.0781 | 0.0918 | 0.1037 | 0.1148 | 0.1252 | 0.1350 |
| | h | 24.67 | 90.06 | 187.4 | 285.9 | 386.2 | 490.6 | 601.0 | 722.7 | 867.8 | 1052.6 | 1232.1 | 1355.2 | 1453.0 | 1532.4 | 1608.2 | 1679.9 | 1751.2 |
| | s | -0.00024 | 0.12414 | 0.28414 | 0.42313 | 0.54706 | 0.66176 | 0.77117 | 0.8806 | 1.0006 | 1.1424 | 1.2698 | 1.3515 | 1.4124 | 1.4579 | 1.5009 | 1.5377 | 1.5739 |
| 9000 | v | 0.01556 | 0.01572 | 0.01618 | 0.01686 | 0.01783 | 0.01914 | 0.02095 | 0.0238 | 0.0284 | 0.0393 | 0.0568 | 0.0726 | 0.0860 | 0.0974 | 0.1081 | 0.1181 | 0.1276 |
| | h | 26.07 | 91.33 | 188.5 | 286.9 | 386.9 | 491.0 | 600.8 | 721.0 | 861.8 | 1036.3 | 1213.2 | 1340.8 | 1442.0 | 1523.7 | 1600.5 | 1673.0 | 1745.6 |
| | s | -0.00034 | 0.12381 | 0.28362 | 0.42238 | 0.54602 | 0.66036 | 0.76909 | 0.8775 | 0.9939 | 1.1271 | 1.2531 | 1.3378 | 1.4008 | 1.4476 | 1.4911 | 1.5284 | 1.5652 |
| 9500 | v | 0.01554 | 0.01570 | 0.01616 | 0.01684 | 0.01780 | 0.01909 | 0.02088 | 0.0236 | 0.0279 | 0.0371 | 0.0527 | 0.6774 | 0.0807 | 0.0920 | 0.1022 | 0.1118 | 0.1209 |
| | h | 27.47 | 92.61 | 189.7 | 287.9 | 387.7 | 491.5 | 600.6 | 719.7 | 857.3 | 1023.8 | 1196.0 | 1326.7 | 1430.9 | 1515.4 | 1592.8 | 1666.1 | 1740.1 |
| | s | -0.00042 | 0.12349 | 0.28309 | 0.42164 | 0.54499 | 0.65897 | 0.76709 | 0.8745 | 0.9886 | 1.1156 | 1.2379 | 1.3246 | 1.3895 | 1.4379 | 1.4818 | 1.5195 | 1.5570 |
| 10000 | v | 0.01552 | 0.01568 | 0.01614 | 0.01682 | 0.01776 | 0.01904 | 0.02080 | 0.0234 | 0.0275 | 0.0353 | 0.0495 | 0.0635 | 0.0760 | 0.0872 | 0.0969 | 0.1061 | 0.1149 |
| | h | 28.84 | 93.88 | 190.8 | 288.9 | 388.5 | 491.9 | 600.4 | 718.4 | 853.3 | 1012.9 | 1181.0 | 1313.3 | 1419.7 | 1507.4 | 1585.5 | 1659.3 | 1734.7 |
| | s | -0.00054 | 0.12317 | 0.28257 | 0.42089 | 0.54396 | 0.65759 | 0.76517 | 0.8714 | 0.9832 | 1.1050 | 1.2243 | 1.3122 | 1.3784 | 1.4286 | 1.4729 | 1.5108 | 1.5491 |

[1] The complete Interim Steam Table prepared by the Subcommittee on Interim Steam Tables of the ASME Power Division is available from Order Department, ASME, 29 West 39th St., New York 18, N. Y., at $1.

## Appendix

*A Equations for Determining H and S from the P-V-T Data.*

The Maxwell relation (Equation [1]) may be evaluated at constant temperature and integrated to obtain the change in entropy at that temperature between the base and desired pressure

$$\left(\frac{\partial S}{\partial p}\right)_T = -\left(\frac{\partial v}{\partial T}\right)_p \quad \ldots\ldots [1]$$

$$(S - S_0)_T = -\left\{\int_{P_0}^{P}\left(\frac{\partial v}{\partial T}\right)_p dp\right\}_T \quad \ldots\ldots [2]$$

A corresponding expression for enthalpy may be derived as follows:

The relation for a pure substance

$$du = Tds - pdv \quad [3]$$

may be transformed into the equation

$$dh = Tds + vdp$$

Dividing this expression by the change in pressure to get, at constant temperature

$$\left(\frac{\partial h}{\partial p}\right)_T = v + T\left(\frac{\partial S}{\partial p}\right)_T \quad \ldots\ldots [4]$$

From Equation [1] we may substitute a volume derivative for the entropy derivative and obtain

$$\left(\frac{\partial h}{\partial p}\right)_T = v - T\left(\frac{\partial v}{\partial T}\right)_p \quad \ldots\ldots [5]$$

A convenient form for future use is

$$(h - h_0)_T = \left\{\int_{P_0}^{P} vdp - T(S - S_0)\right\}_T \quad \ldots\ldots [6]$$

where

$S$ = entropy
$h$ = enthalpy
$T$ = temperature
$p$ = pressure
$v$ = volume
0 = (subscript) reference conditions

Equations [2] and [6] were used to determine the changes in entropy and enthalpy from 5500 psia between 32 and 840 F.

*B Numerical Method of Differentiation to Determine* $(\partial v/\partial T)_P$

The tabular values of $v$ versus $P$, $T$ were numerically differentiated to obtain $(\partial v/\partial T)_P$ using a method based upon Lagrangian polynomials and described in reference (7).

The differentiation formula for the first derivative at the central point of five equally spaced points is in our terminology

$$\left(\frac{\partial v}{\partial T}\right)_p = \frac{1}{\Delta T}\left[0.083333(v_{T-2\Delta T}) - 0.666666(v_{T-\Delta T}) + 0.666666(v_{T+\Delta T}) - 0.083333(v_{T+2\Delta T})\right] \ldots [7]$$

Since this method required values two increments above and below the desired value it was necessary to extrapolate the tabular values of volume to 0 and 680 F to obtain derivative values from 40 to 640 F.

*C A Numerical Method of Integration to Determine*

$$\int\left(\frac{\partial v}{\partial T}\right)dp \quad \text{and} \quad \int vdp$$

The integration for the interval from 5500 to 6000 psia was performed using the 6 point-5th degree quadrature formula (8)

$$\int_0^1 ydx = \frac{l}{1440}\left[493y_0 + 1337y_1 - 618y_2 + 302y_3 - 83y_4 + 9y_5\right] \ldots [8]$$

The remaining increments were integrated using Simpson's rule (9)

$$\int_0^2 ydx = \frac{l}{3}\left[y_0 + 4y_1 + y_2\right] \ldots\ldots [9]$$

Since Simpson's rule evaluates the integral over two intervals the rule was applied starting from 5500 psia to obtain the $\Delta$ at the 6500, 7500, 8500, and 9500 psia levels and starting from 6000 psia to obtain the $\Delta$ at the 7000, 8000, 9000, and 10,000 psia levels.

*D A Numerical Method for Determining the 5500 Psia Values of V, H, S.* The Keenan and Keyes tables contain values of $v$, $h$, and $s$ at 5500 psia for 100 deg F intervals between 100 and 600 F. In order to obtain values at 20 deg F increments Newton's formula for forward interpolation (9) was applied to the tabular values.

For enthalpy versus temperature this becomes for our particular case

$$h = h_0 + \frac{T - T_0}{\Delta T}\left[\Delta^1 h + \frac{T - T_1}{\Delta T}\left[\frac{\Delta^2 h}{2} + \frac{T - T_2}{\Delta T}\left[\frac{\Delta^3 h}{3} + \frac{T - T_3}{\Delta T}\left[\frac{\Delta^4 h}{4} + \frac{T - T_4}{\Delta T}\left[\frac{\Delta^5 h}{5}\right]\right]\right]\right]\right] \ldots [10]$$

which is in continued product form useful for computer use. A similar equation may be written for entropy and volume. The 5500 psia values at 40, 60, and 80 F were obtained by an extrapolation of the difference table for the 100 to 200 F range.

# The Mechanization Profile—

## *A Tool for Measuring Automation*

**By James R. Bright**[1]

**Harvard University, Cambridge, Mass., Member ASME**

THIS paper offers an analysis of mechanization and a method of charting it which has proved useful in studying some 15 so-called automation plants.

The production of goods involves a number of basic functions. The production operation—processing—is the thing we instinctively visualize as the heart of the automatic factory. But design, handling, storage, maintenance, and measurement also are essential. If the plant is to approach automaticity, even remotely, there must be a high degree of mechanization of each of those functions, not just of processing.

### Three Qualities of Automation

A simple chart can be constructed that will suggest the nature of mechanization generally associated with these functions. Such a chart, Fig 1, does not need to be absolute and precise to show that today there is no such thing as an automatic plant or even a push-button plant, and that mechanization is not found equally distributed through any single production sequence, let alone any whole plant or industry. Note, further, that automation can be analyzed in terms of three different qualities:

***Span of Mechanization.*** Over what portion of a given total manufacturing sequence does the mechanization extend?

***Level of Mechanization.*** How high a degree of mechanization characterizes the particular function or activity?

***Amount of Mechanization.*** How prevalent is mechanization of a given function or activity in the industry as a whole?

### Mechanization Profile

The concept of degrees of mechanical art approaching automaticity in successive steps—levels of mechanization—suggests that there must be different things that machines do. In what way does machinery supplement man's muscles, his senses, his mental processes, and his judgment? Are there significant differences in the levels of mechanization? And if automation is so different, where does it fit in?

It would seem that it is quite possible to think our way through these things by a systematic qualitative analysis of the functions of simple and complex machinery. It has been possible to distinguish 17 levels. This particular breakdown cannot be defended too rigorously. Examples can be cited that would somewhat confound this or any other classification. Doubtless additional subdivisions could be defined. Furthermore, some of these levels may be inextricably tangled with much lower levels. Nevertheless, the following have been found to be fairly consistent and usable:

***Level 1—Hand.*** The least mechanical way that man manufactures something is usually with his hands; occasionally with his feet, knees, elbows, or even his lungs (glass blowing). No tool of any sort is used. Examples are manual packaging operations, inspecting, and many assembly operations.

***Level 2—Hand Tool.*** An enormous amount of work is performed by the human hand aided by a nonpowered tool. Even on an automobile assembly line many workers will be found tightening nuts and bolts with a hand wrench or inserting wires and rods through holes by the aid of pliers or similar devices.

***Level 3—Powered Hand Tool.*** The next step is to provide mechanical power to the tool held by the worker. The power screw driver, the portable drill, and the portable welding machine exemplify this level of mechanization. Power supplements the worker's muscles, but actual guidance of the tool still is under his control.

***Level 4—Power Tool, Hand Control.*** The simplest form of machine tool appears at this level. A drill press, for instance, provides power to the tool and also a framework that guides the tool. Application to the workpiece is physically actuated by the operator, who controls the amount of action as well as its duration. In other words, the machine performs within fixed dimensional limits and rates built into it, but the operator controls the application of such action. Such a machine can be mobile, as well as stationary.

***Level 5—Power Tool Fixed Cycle (single function).*** This machine repetitively performs a single action that is mechanically fixed within definite limits. A drilling head arranged so as to advance, drill a 1-in. hole, and retract, all automatically, reflects this type of mechanization. A belt conveyer moving packages from the end of the production line to the shipping room at a set speed also performs a single action in an unvarying way.

It is implied that this machine action is mechanically (automatically) controlled, even though an operator may have to push a button to start the machine and stand by as an observer. But this does not invalidate the basic point; the machine itself controls a simple action over the desired range of performance.

***Level 6—Power Tool, Program Control (sequential functioning).*** This step is similar to the previous one except that the machine performs a series of actions in sequence, operating in one or both of two basically different ways: (1) The workpiece is held in a given position, and the different tools are brought to it for the period of their

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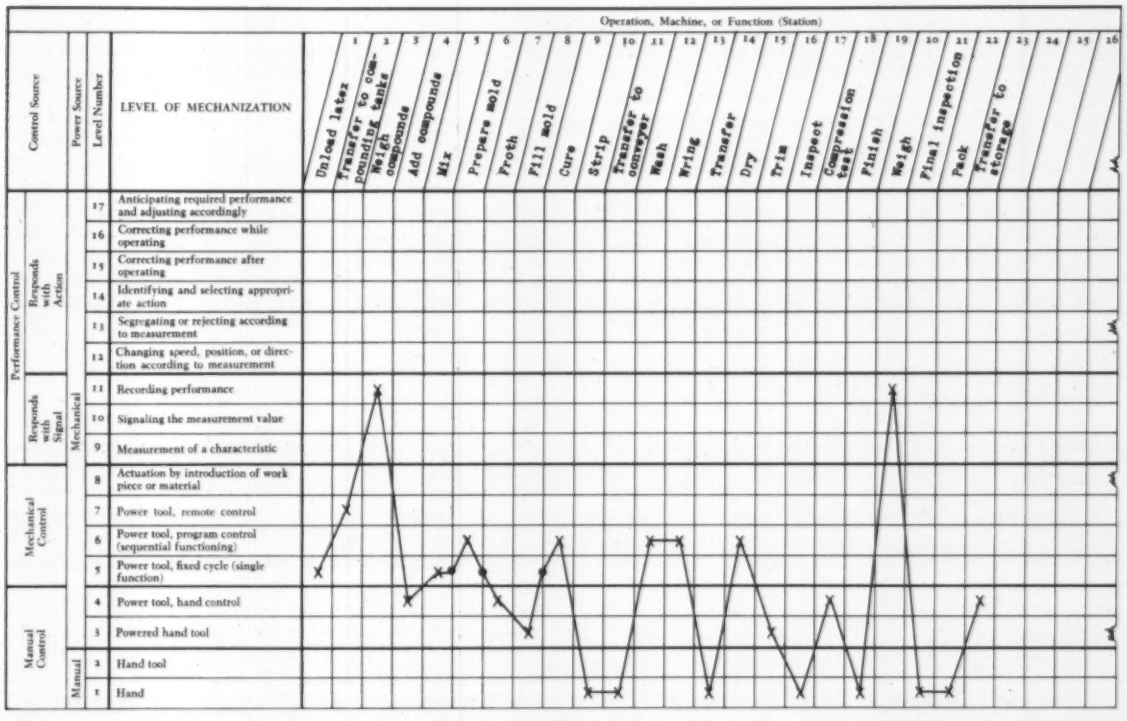


NOTE: Dots on lines between operations represent the level of the materials-handling device.

**Fig. 1 Mechanization profile—rubber-mattress unit. (Reprinted from the July–August, 1955, issue of the *Harvard Business Review*.)**

individual cycles—the principle of the automatic turret lathe. Or (2) each operation is performed at its own fixed station; then the workpiece is passed to successive stations under automatic timing, positioning, and materials-handling control—the principle of a dial-indexing machine tool. The automobile industry's transfer machine combines both of these concepts.

It is rather interesting that this level of mechanization is found in our current home appliances such as the automatic washing machine, the automatic drier, and the automatic dishwasher. All of these work on the first principle rather than on the second one. In the industrial plant, because of unique variations in the average product, we find more and more emphasis being put on the second approach for assembly work, though the first is still useful for processing.

***Level 7—Power Tool, Remote Control.*** Meanwhile the control of the machine is undergoing some changes, too. While it might be argued that this is not a clearly defined level of mechanization since it is also found fragmentarily at least three levels earlier, this seems to be about the best place to establish remote control in the scheme of things.

The principle is that the control of the power tool is located a significant distance from the tool itself. Where a single tool is concerned, this holds no special significance. But, when a group of power tools is equipped with remote control, the impact on mechanization mushrooms. It becomes possible to assemble the control of a series of machines in one central location. Thus the whole industrial art is advanced a significant step closer toward automaticity.

Remote control implies fewer people, but this is not the most important implication. Centralization is far more important. It generally means much faster "reaction time" to the needs of the various production operations, particularly as they affect each other. Thus improvement in quality, reduction in scrap, and higher machine efficiency through optimum operation of the plant as a whole are likely to follow.

This level of mechanization eliminates the delays and errors inherent in the communication of information between human beings at widely scattered locations. The lack of this level of mechanization probably is responsible for the excessive paper work, elaborate production-control systems, and general inefficiency of flow apparent in the average job shop. (It is not meant to imply that it is always practical or economical to change procedure. The thought is merely, to emphasize that such "looseness" in control is the target of this seventh stage of mechanization.)

***Level 8—Actuation by Introduction of Workpiece or Material.*** In all the previous phases of mechanization, the human element is required to actuate the system. In advanced mechanization even this need begins to disappear.

It is no longer uncommon to find machines that "idle" or remain inactive until started by the introduction of the workpiece. This is a feature of many of the automobile industry's new compound machine tools, whereas the transfer machines of five years ago usually cycled continuously whether or not a workpiece was present.

***Level 9—Measurement of a Characteristic.*** Now we begin to move into levels of mechanization where there is a

new emphasis on control, rather than a pattern of operation. We see machines that not only change the form of the object but, with certain mechanisms added, also measure some characteristic of the object—weight, temperature, a dimension, a shape, a color—either before, during, or after production.

***Level 10—Signaling the Measurement Value.*** A logical refinement of the previous level is to include a device that will signal when the measurement value is in a certain area or reaches a certain limit. In effect, the machine calls for human help. Sometimes the machine is designed to yield several kinds of signals (different-colored lights or sounds) so that the nature of the measurement value can be quickly grasped by the human machine tender. This is particularly useful in the case of errors or difficulties. Overdimensions or underdimensions might be so signaled.

It is a very short further step—so short that it is not regarded as more than a special case of this same level of mechanization—to have the machine shut down until it is "cleared" by its attendant.

***Level 11—Recording Performance.*** Often it is desirable to have a record of machine performance. This may range from a mere count of the number of pieces produced (or tons, gallons, yards, and so on) to a record of individual values of the characteristic measured almost moment by moment.

A recent refinement has been to incorporate signaling along with recording. At least one such data-scanning device prints values in red if the value exceeds a preset limit for a particular instrument. Thus the panel attendant or engineer can see at a glance which values are out of control.

***Level 12—Changing Speed, Position, or Direction According to Measurement.*** One of the most important advances toward automaticity is the development of machinery that automatically modifies its action in accordance with the information received through some kind of sensing device—the principle of feedback.

However, the idea of feedback itself seems to employ different degrees of mechanization. At this particular level we are not talking about the correction of performance based on the quality of the output. Rather, the machine is controlled by a signal and is not influenced by the precision of its own processing action. For example, in a brewery a roller-conveyer system counts the number of cartons coming down a line; and then, after 50 have passed, it switches to direct the next group of cartons to a different location.

Perhaps we might distinguish this phase of mechanization from earlier levels by saying that the performance of the machine is controlled by a signal rather than by a fixed program. It is more flexible in action and in the time dimension. But while this machine changes its action at a signal, it does not inspect its own performance.

***Level 13—Segregating or Rejecting According to Measurement.*** Implicit in the previous level is the next step of automatically accepting or discarding a product that does not meet a prescribed standard. Note that in Level 10, all the machine does is to inspect and signal for human help; it takes no action on the substandard work. But at Level 13 we find machines that not only measure and decide on acceptability but also dispatch the work accordingly. An example is found in a textile mill where picker laps coming from the picker room are automatically weighed just prior to dispatch to the looms. If the weight is not up to the desired standard, the individual lap is automatically rerouted back to the picker room for rework. Acceptable products automatically pass on to the loom room.

Notice that although this is a high level of mechanization in the sense that it employs decision and physical separation, the actual execution can be very simple indeed. "Measurement" here may be nothing more than the sensing of form and the adaptation of some kind of chute, divider, or separator that will direct one form one way and everything else another. In very elemental form, a punch press may be rigged to separate the scrap from the finished parts; or a bottling machine may include a weighing device which will separate out incompletely filled bottles. "Decision" is pretty much a "yes or no" choice, although it may involve a choice from three, four, or even more alternatives.

***Level 14—Identifying and Selecting Appropriate Action.*** Now we come to the machine that, in theory at least, takes more complex action. This machine examines the incoming product and adjusts itself to perform accordingly. For instance, a recently introduced machine tool receives two types of castings. It automatically distinguishes between them and puts each casting through a different set of machining operations as the two pass through the same series of work stations.

Admittedly, this is not very much different from the preceding level. The significance lies in the fact that the response of the machine covers a wider range and is more complex. Instead of a single-action response—an inspection and materials-handling sequence—there may be a modification of performance involving a whole series of varying subsequent actions.

***Level 15—Correcting Performance After Operating.*** On this level we find the machine that examines its performance and then readjusts itself accordingly to turn out a more nearly perfect product. To a very limited extent, this feature has been employed in some machine tools, which will grind or perhaps otherwise remove material, inspect it, and then translate the inspection information into corrective action so that the next piece is machined properly.

But even though inspection and correction are automatic and tied together, the inspection after operation implies a time lag. And the more time, the more opportunity for faulty parts to be created before the correction is introduced.

***Level 16—Correcting Performance While Operating.*** Theoretically the ideal machine would control itself so that it would never turn out a faulty part. It would inspect continuously and modify its performance quickly enough so that potential faults would be avoided.

It is hard to find machines that fully meet this definition. Perhaps the nearest are the electrical machinery devices with their marvelously precise output controls. They will maintain speed, torque, voltage, or current, as the case may be, within amazingly fine limits. Some chemical operations, particularly the control of temperature and the control of pressure, also fall within this area.

***Level 17—Anticipating Required Performance and Adjusting Accordingly.*** There is still one higher level. We have a few isolated examples of machines that not only sense something and correct their actions but also extrapolate the governing data or act on a lead from the probability pattern (or otherwise anticipate the action needed to produce the required performance), and then

regulate themselves accordingly. Self-guided missiles come to mind as the outstanding example.

Oil-refinery developments are beginning to get into this phase. Engineers visualize the application of instrumentation that will sense the change in a variable, predict what will develop and the corresponding series of changes needed in the process, and then change the various machine responses accordingly. This is more than the measurement of a characteristic and a response. It is the measurement of the rate of change in the characteristics, the anticipation of the control modification needed, and then the modification of a host of variables to hold the process with design limits.

### Relationship Between Mechanization Levels

If these levels of mechanization are arranged in order on a chart, certain important relationships between them fall into place. Consider the nature of the power used at each of these levels. Only the two lowest ones use manual power; all the rest are based on mechanical (nonhuman) power.

Even more significantly, the 17 levels are distinguished from one another by the nature of the control characteristic of each:

Notice that the first four levels of mechanization all employ manual control. There is an interesting difference between Levels 3 and 4. At Level 3—the powered hand tool—manual control can be thought of as embracing two elements, namely, application and guidance. At Level 4, however, we can see that one aspect of this control job has been further mechanized—the aspect of guidance. The construction of the tool fixes the limits of the physical action. The operator merely guides the tool or "controls" it within those mechanically fixed paths. He has only limited control in the three physical dimensions but retains complete control in "time."

In passing to the fifth level of mechanization—the fixed-cycle power tool—it is apparent that we have not only mechanized the guidance of the tool, but we also have mechanized its application in the time dimension. Other than starting and stopping the machine, or possibly modifying its speed, the tool is completely mechanically controlled. Level 6 is nothing but a more advanced form of Level 5. Level 7 has remote control, often applied to the next three lower levels; this is inserted at this point because it enables the centralization of control of a number of machines. Finally, we have the machine controlled by introduction of the workpiece.

At the ninth level of mechanization a new force is becoming predominant in the control action. The environment, the product, or the nature of the operation itself at given moments becomes the initiating element of the system. Control here is no longer mechanical, fixed, or rigid; rather, it is variable according to performance. The control indication may be prior to, or during, or after the production act has been performed. Thus we see the basis evolving for still higher levels of mechanization. The principal importance—the principal distinction at this point—is that control itself is becoming a variable.

In the ninth, tenth, and eleventh levels the control response is not a specific action of the machine as much as it is a signaling action. We might say that the machine has verified the nature of the performance, and it either reports this performance and/or calls for human attention.

At the twelfth level a new quality to control has been introduced. The control responds with action. All the succeeding levels of mechanization embody the idea that the machine measures completed, current, or impending environment, and modifies its major functioning accordingly. In the lower of these levels the action response is very limited in character. In the higher levels the response is not so much of a yes or no matter. It is broader, richer, much more complete.

### The Meaning of Automation

Some disciples of automation see it as embracing the idea of automatic control. To them, control rather than mechanical automaticity, is the dominant factor; indeed, automation is synonymous with automatic control. This group seems to be applying automation to the levels of mechanization from roughly 9 to 17. However, some of them insist that it is not really automatic control until it embraces only Levels 12 to 17.

Other enthusiasts lay heavy stress on feedback. They have said or implied in many ways that "true" automation embraces the idea of self-correction. Other steps toward automaticity, they maintain quite condescendingly, are nothing but mere "Detroit mechanization."

However, automation is not quite so simple as more careful analysis of these 17 levels will demonstrate.

***Practical Levels.*** After looking at these levels and their application to a manufacturing sequence, what do we mean by automation? Where does automation fit in? Is automation new and different? What is unique about it?

It seems clear that practical industrialists who must use mechanization are interested in an end (i.e., automatic manufacturing), while many of the enthusiasts are obsessed by the means (i.e., automatic control, handling, or processing). Thus, to insist on automation as relating to just a certain aspect or certain levels of mechanization is downright foolish to the user of equipment. Automaticity may or may not require self-regulation. It is important to realize that many highly automatic operations do not require performance control. There is nothing excellent, brilliant, or economic in employing higher levels of mechanization than are needed. Countless cases can be cited where automatic operation—or, more correctly, a high degree of automaticity—has been achieved on Levels 5 and 6. To the extent that the required activity is reasonably uniform in input, throughput, and output requirements, there is no need of automatic control. Indeed, to introduce automatic control into many of these situations becomes a ridiculous mechanical luxury. Often it leads to a downright reduction in economic efficiency through high engineering costs, high maintenance costs, and limited flexibility.

This is not to deny the steady growth and important application of controls to reach new advanced levels of mechanization. Furthermore, experience is showing that direct labor reduction is not the only advantage—and often is not the major advantage—arising out of automaticity. Savings in material through reduction of scrap, reduction of inventory, and refinement in product design are often the major advantage. Improvement in

quality has been the significant advantage in a number of cases.

Rather, it should be stressed and restressed that countless machines and groupings of machines already have achieved and will continue to achieve the most economic level of mechanization far short of full automation.

### Automation or Mechanization?

From 15 or so profiles made of actual operations, it is clear that:

1 Most instances of automation turn out to be largely automatic-operation systems not embodying self-regulation. There is little or no use of the higher levels of mechanization.

2 With the level of mechanization varying widely as between industries and between parts of the individual production cycle, automation is being used to describe something on a significantly higher level of mechanization than previously existed in that particular activity or plant, rather than any certain minimum level of mechanization of automaticity. What is called automation in the bakery business, for example, is everyday mechanization in the automobile industry. What is a significant advance in mechanization in metalworking, let us say, is commonplace in a brewery. This does not imply that one field is much more backward than another. Rather, economics, technical problems, and mechanical art vary widely between industries. One man's automation is another man's daily practice. Automation is relative, not absolute.

3 Automation usually covers a very small part of physical manufacturing activity and next to none of the mental activity required. Since automation is being introduced as islands of automatic operation in the total sequence, it suggests the need for a thoughtful look. Are these islands adapted to further integration, either as a whole or as part of a larger island? There is evidence that engineers should give more attention to long-range mechanization planning. Buying unrelated elements of automation piecemeal may be expensive, inefficient.

4 A major element in achieving automaticity is the mechanization of handling. The conveyer in some form, and occasionally the monorail, is the heart of most highly mechanized plants. Processing is being built around, on, and into the conveyer. Automatic production is impossible without automatic movement. The automatic processing machine is only the first step, rather than the last, on the road to the automatic factory.

5 A significant result of higher levels of mechanization is the reduction in space requirements for production facilities. With automatic controls, many machines are performing more functions than formerly, so there can be less equipment. Other machines are being placed close to each other for transmission of fabricated parts. Handling systems are linking major production centers with each other and with raw-material and finished-goods storage. Less space is needed around production operations because there are fewer operators, traffic passageways, and materials in process. Certainly, the engineer who sees a long-range space problem should consider the possibilities inherent in automation.

6 We have a long, long way to go to reach full automaticity. Automatic processing is relatively easy. Automatic assembly is the glaring weak spot; next to nothing has been done in this area except in the bulk-materials field and a handful of very high-volume discrete-part manufacturing plants. Product inspection, in spite of certain dramatic advances, also is astonishingly unmechanized throughout industry. The human being's versatility, sensitivity, and power of discrimination, plus materials-handling ability, are unique. They make him far and away the most economic inspection "device" except for the very precise and/or the highly repetitive inspection activity. Where a combination of factors must be considered in inspection—for instance, cracks, flaws, appearance, texture, general quality—it is a rare machine that can beat him.

*Theoretically Desirable.* A mechanization profile can be made both of the actual level of mechanization and of the theoretically desirable level. A systematic comparison of these two curves will highlight important gaps, and the engineer can then consider whether or not the expense and the time necessary to raise the level of mechanization for a given operation seem to be reasonable. Even more important, such analysis will suggest whether this effort might be better directed elsewhere in the total manufacturing cycle.

### Refining the Profile

This profile technique is new and unrefined. It should not be adopted blindly or overenthusiastically. Perhaps its greatest value is its use as an aid to orderly and careful consideration of new concepts and methods in mechanization.

Eventually, it may be possible to quantify the profile in some way so that the productivity could be related directly to the level and the span of mechanization. Perhaps different systems might be compared quantitatively and, therefore, more accurately. This might lead to the ability to measure mechanization in absolute terms so as to compare industries and systems and to measure historical progress.

However, the user should be very careful not to be misled by this rough tool. He should always remember these facts:

1 A profile can fall into lower levels of mechanization and still the operation may be quite "automatic." Many machines, which we take for granted, actually perform and tie together a number of operations. Thus the fixed-cycle machine provides a great deal of automaticity.

2 There is nothing economically virtuous per se in the higher levels of mechanization. A system is neither "good" nor "bad" because it is high or low on the profile chart. We should not assume that mechanical achievement implies economic excellence. The point of diminishing returns is just as true in mechanization as in anything else.

3 Automation is not an absolute, but a relative. It is not by accident but by design that a rigid definition has been avoided from the very beginning of this paper and that a number of phrases have been used to imply the act of doing things "more automatically." That is how automation actually shapes up—in current practice and for some years to come—as degrees, steps, levels in the advance of mechanization.

In short, an intelligent analysis of mechanization will help us to understand what is going on—to compare systems—to highlight weak spots. Thus the mechanization profile may become a useful tool to broaden our perspective of technical progress.

# Where to Now?

## World-wide management activity proposed as a contribution toward a lasting peace

**By Harold B. Maynard, Member ASME**

President, Methods Engineering Council, Pittsburgh, Pa.

**Wallace Clark International Award**

On February 25, 1949, the Wallace Clark International Award was established by The American Society of Mechanical Engineers, American Management Association, Society for the Advancement of Management, and the Association of Management Engineers, as an annual award to be presented through the National Management Council of the United States.

The award perpetuates the memory of the late Wallace Clark, Fellow ASME, who during the period between the wars was the foremost proponent of American concepts of scientific management and industrial democracy in Europe. His philosophy expressed simply as "remove all obstacles to a free flow of work . . . from the bottom up, not from the top down," which he preached and applied in Poland, Germany, France, and other European countries, was an exciting concept to European engineers struggling with the task of reviving disrupted industry following the first world war.

The award consists of a gold medal, a citation, and an autographed copy of the book "The Challenge of American 'Know-How,'" by Pearl Franklin Clark. Mr. Maynard, the 1956 recipient of the award, was cited "for his distinguished contribution to scientific management in the international field."

It seems only yesterday that Wallace Clark and I were riding together on the train to Atlantic City to attend an annual meeting of The American Society of Mechanical Engineers. I had just returned from Paris from my first meeting as United States representative on the Executive Committee of the reconstituted International Committee on Scientific Management, CIOS. It had been a stormy session. Most of the members of the executive committee were strangers to one another. They had not yet learned to work together in a spirit of good will and intelligent compromise. Many of the delegates seemed more interested in advocating their own national viewpoints than thinking in terms of developing internationally acceptable solutions to their common problems. Although the meeting was handled with consummate skill by the president of CIOS, Mr. Assar Gabrielsson, when we finally adjourned after three difficult days of discussions, very little of real value had been accomplished.

As we rode toward Atlantic City, I told Wallace Clark of the meeting and of its frustrations and disappointments. He responded in his calm, quiet, matter-of-fact way with some of the soundest advice on how to get along in international groups that I have ever heard. He made clear the background of some of the things that had happened at the meeting and helped me to see the course that would have to be followed in the future to bring cohesion and unity into a situation that was potentially disintegrative. His calm optimism and his utter faith that with persistence and growing understanding a solution to our problems would eventually be found were a wonderful inspiration to one who was just getting his first taste of international affairs.

### International Understanding

In the years that followed great progress was made. In CIOS a spirit of patience and understanding developed, and its influence toward better management became far-reaching indeed. All who have had contact with CIOS have felt the impact it has had on management thought throughout the world.

The National Management Council—now known as CIPM—has made a tremendous contribution. Through its seminar teams abroad, its competent handling of visiting groups here at home, and in many other ways, it has spread the knowledge of American management techniques and procedures to our overseas friends.

As a result of these activities, and not overlooking for a moment the contributions of the other national committees of CIOS and the whole government-sponsored productivity movement, a knowledge of good management has spread far and wide. Furthermore, the two-way bridge that we used to talk of so much is today established, and we are constantly receiving as well as giving management information.

But can we now sit back and view with satisfaction the work that has been accomplished? With overseas factories humming, with standards of living rising all over the world, with our management techniques either known or readily available to any who want them, can we feel that our work has been done and that we now can afford to relax?

A symptom that we are presently reaching the point where we are willing to consider our work done lies in the attitude which some of us are taking with regard to membership in CIPM. A number of people have asked my opinion recently on the advisability of continuing

Address following presentation of Wallace Clark Award, at luncheon, New York, N. Y., April 11, 1956. Condensed.

the membership of their companies in CIPM when the time for renewal comes along. More than one has commented in effect: "We were perfectly willing to help out when help was needed. But now, industries in other countries are doing all right. In fact, they are starting to give us some pretty stiff competition. Why should we help our competitors any more?"

### Next Objective—Peace

Why indeed, if we are willing to stop with two thirds of our formula satisfied? We have helped to create good management, production, and prosperity. But what of the final step—peace? Can we assume that when people are prosperous, they automatically will be inclined to peace?

In the brief periods between wars, mankind has shown itself capable of building up its material prosperity at an astounding rate. But then as everyone begins to get comfortable and secure, human nature seems to go to work. The unity, the humbleness of spirit, the willingness to work together co-operatively for ends larger than the interests of the individual so prevalent when conditions are adverse, seem to diminish in inverse proportion to prosperity. We begin to find dissension creeping in—selfishness, indifference to the needs of others, a hunger for personal power. One of the most dangerous points is reached when we stop trying to get along with people in other lands, people whom a short while ago when they were in need we helped so generously.

But need it always happen? We used to feel that violent ups and downs of the economic cycle were unavoidable. Finally we did something about it, apparently with considerable success. We are dangerously close to the degenerative phase of the human-relations cycle at the present time. Can we not recognize this and do something about it before it is too late? Now that we are ahead in the struggle for survival against the forces of external nature, can we not turn some of our inventive genius, some of the creative urge with which we are so richly endowed toward the solution of the problem of survival against the forces of human nature.

### The Spirit of Good Management

We have done quite well in the development of the techniques of good management. What we must do now is to develop something that goes deeper, something that we might call the spirit of good management, and then we must see that this is spread throughout the world.

Great as is this goal, it is a goal that each one of us can do something about. We in management do not have to look far to find an inspiring example of what can be done by a single individual dedicated to the improvement of human relations. Wallace Clark was outstanding in this respect. I have met many people all over the world who knew him. Whenever his name is mentioned, their faces light up. A spirit of friendliness which is a reflection of his own humanity shines through. His influence on the lives of the people with whom he came in contact was lasting and always in the direction of peace and harmony. These people are living monuments to the influence for good that can be exerted by one man. We must have more men of his character throughout the ranks of management.

It has been suggested that the Council for International Progress in Management should undertake as its next major project the establishing of a management-development activity on a world-wide basis. What a challenge this project presents.

**It is entirely possible that the project of establishing a world-wide management-development activity can be so organized and formulated that it can become a moral equivalent for war for us in management. The development of a new race of managers, men who can do in depth the job of improving human relations that so badly needs to be done, can be a challenge worthy of the energies, the sacrifices, the creative effort of all of us. The goal of ultimate world peace is the most important faced by mankind. We in management have a unique opportunity to make an important contribution.** ***The Author.***

In decrying the state the world is in, it is fashionable for the older generation to admit its failures and to pass the burden of bringing about a better day on to the next generation. But I doubt if we who are now in management can afford that luxury if there is to be any next generation. The need is now, and right now we are the ones who are important influencers of thought. If peace is to prevail, it will be because we worked for it instead of leaving it to someone else to do.

If we take up this crusade of seeking improved human relations by developing better managers, we must do it humbly in the spirit of those who seek a goal and not as those who already have answers to pass on to others.

In setting a goal for ourselves, what better example do we have than the man whose memory brings us together on this occasion. As the tribute published in the Golden Book of Management puts it in part:

"Wallace Clark possessed many of the natural attributes of leadership: poise, knowledge, simplicity of expression and bearing, helpfulness, objectivity, direct but tactful utterance, discretion, devotion to long-range aims, carelessness of self. Small wonder, then, that he exercised a strong and lasting influence over thinking and planning in management and related fields."

### Contribution to Peace

We who are in management face a challenging problem. We have the opportunity of making a lasting contribution to world peace if we care to accept the challenge. The problem is one which will need the best thinking on the part of all management men everywhere in the world. If we in America choose to take the initiative in beginning to work on the problem by the approach of developing better managers, we must be prepared to pursue our goals at the international level with patience, understanding, and a willingness to share the decisions on what is to be done with others.

So we in CIPM may well ask ourselves "Where to now?" We have accomplished much in the past nine years in helping the world get on its economic feet. We undertook to help on a large task and contributed an important share to its ultimate accomplishment. Now there is an even more important job to be done. May God grant that we will have the wisdom to do it so that all men everywhere will gain thereby.

# Suspension-Drying of Sawdust

## *Efficiencies of 70–80 per cent realized from flash-drying system*

**By S. E. Corder,[1] C. O. Morris,[2] and G. H. Atherton[1]**

Oregon Forest Products Laboratory, Corvallis, Ore.

SUSPENSION-drying is a drying method whereby relatively small particles are introduced into a hot gas stream. The particles are conveyed and at the same time dried by direct contact with the gas. Gas temperatures are normally in the range 500 to 1500 F and

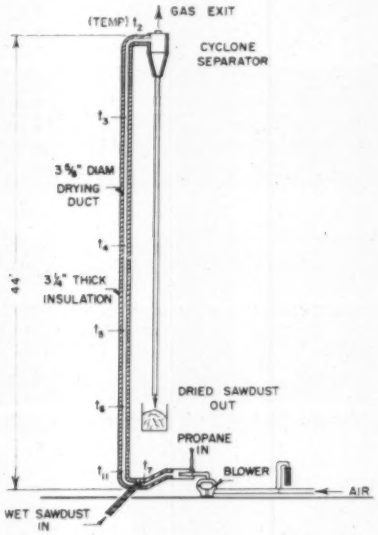


**Fig. 1 Experimental setup of suspension drier for sawdust**

contact time between the particles and the gas is short, a matter of seconds. Suspension-drying is frequently called flash-drying because of the short duration of contact between particles and gas.

The objective of the investigation was to obtain information on the performance of a suspension drier drying sawdust so that the information could be used for design. Suspension-drying systems are not new, as they have been used to dry many materials including coal, bark, starch, and lignite. In addition, several of these systems are being used to dry sawdust or similar wood particles. Most of the present suspension driers for

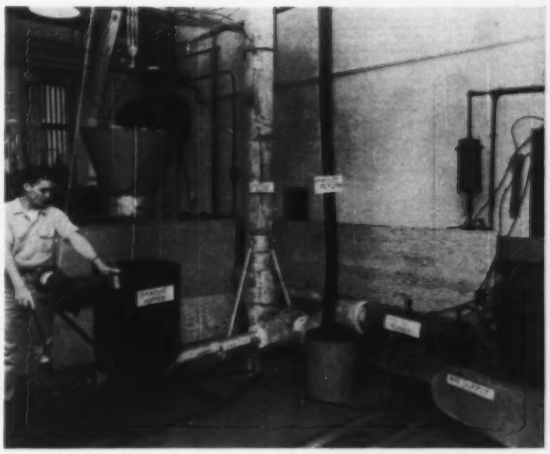

**Fig. 2 View of lower section of experimental suspension drier**

wood particles are used for drying material used in making wood briquets. In recent years, increased use of sawmill residues for briquetted fuel, particle board, hardboard, and molded products has stimulated interest in an economical high-capacity drier for wood particles. Most consolidated wood products require wood particles dried prior to manufacture. Where dried wood particles are required, suspension-drying could be used.

Another possible application of the suspension drier is in drying of wood-waste fuel for steam boilers. Here, waste stack gas could furnish heat for the drying operation.

Although several suspension driers are being used to dry sawdust, a literature search revealed little published information that could be used for design. Accordingly, this study was instigated to provide needed information.

### Principles

Drying is essentially a heat-transfer process; therefore the general heat-transfer equation, $Q = UA\Delta t$, is applicable. The suspension drier has a high heat-transfer rate because: (1) high gas temperatures result in a high value for $\Delta t$, the temperature difference between material being dried and the heated gas; (2) the contact area $A$ of the particles being dried is a maximum since the particles are completely exposed to the drying gas; and (3) the over-all heat-transfer coefficient $U$ is numerically large because of a high relative velocity between the drying gas and particles. Since all three

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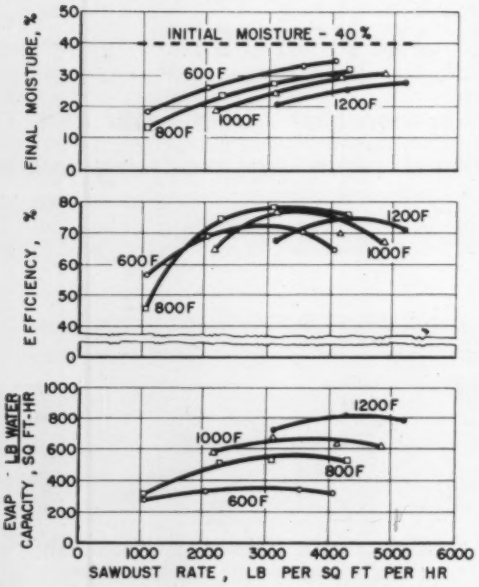



Fig. 3 Drier performance at 4180 lb of air/sq ft/hr

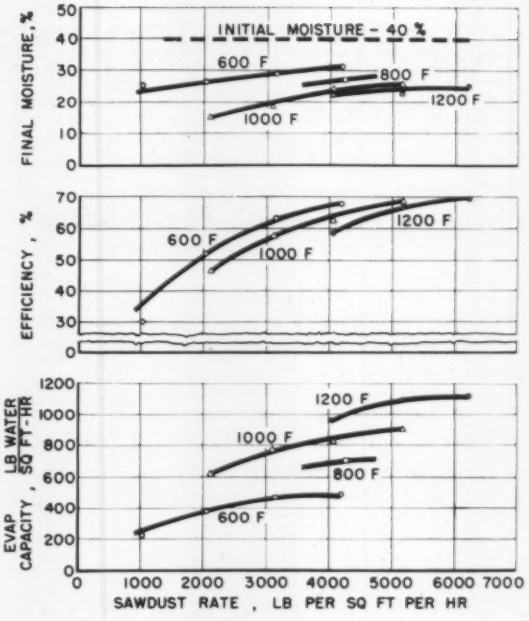



Fig. 4 Drier performance at 6130 lb of air/sq ft/hr

items in the general heat-transfer equation are large, the heat-transfer rate $Q$ is high.

In the drying system, heat is added to the incoming air at the burner. This heat will:

1 Increase the heat content of water evaporated from the wood.
2 Increase the heat content of water remaining in the wood.
3 Increase the heat content of wood material.
4 Be discharged in the exhaust gases.
5 Be lost by radiation.

Only that portion of heat which evaporates water, item 1, was considered as useful. Therefore drier efficiency was defined as the heat used to evaporate water divided by the total heat added. Total heat added was determined from the weight-flow rate, specific heat, and temperature rise of the gas.

On first thought, it might seem that a heat-sensitive material such as sawdust could not be exposed to temperatures as high as 1200 F. However, the sawdust particle contains moisture upon entering the gas stream and the particle tends to stay at the adiabatic saturation temperature of the gas, which is below 212 F, until the moisture is evaporated. Heat for evaporating moisture must come from the gas, thus lowering the gas temperature. By the time moisture is removed from the particles, the gas is at such a low temperature that there is little tendency to char or burn the wood.

Particle size is important in the performance of a suspension drier. Other investigators have shown that the time required to heat a particle to a given condition varies as the square of the particle diameter. This factor limits practical application of suspension or flash-drying to material of relatively small particle size. It also has been determined that the drying rate of wood is governed by heat transfer rather than diffusion when the wood is less than $1/4$ in. thick. Heat transfer, therefore, is the controlling factor in suspension-drying.

The difference in time required to heat particles of various sizes indicates that small particles would become drier than large particles. However, the small particles move through the system at higher velocities and have shorter contact times than do larger particles. The differences in contact time equalize somewhat the moisture contents of particles of various sizes. There are two forces acting on the particle in the drying duct, gravity and fluid drag. The weight of the particle acts downward while the fluid drag acts upward in the direction of gas flow. A wood particle $1/8$ in. diam requires a gas velocity of about 500 fpm when fluid drag is equal to particle weight, but a particle $1/4$ in. diam requires a gas velocity of about 1200 fpm for the two forces to be equal.

Thus the time that a particle is in the drying duct is shorter for small particles than for larger particles. Since the larger particles require a longer time to be heated, the difference in contact time results in particles of more uniform moisture content.

### Test Equipment

Fig. 1 is a sketch of the system used for the sawdust-drying tests. Air was supplied by a positive-displacement blower. From the blower the air flowed to a propane burner. Temperature of the gas leaving the burner was controlled by regulating burning rate of the propane. Hot gas leaving the burner entered the base of the drying duct where sawdust was introduced by a screw feeder. Drying of the sawdust took place as the sawdust was conveyed upward through the drying duct. The drying duct was a pipe with $3^5/_8$ in. ID, about 45 ft in vertical height, covered with insulation $3^1/_4$ in. thick. At the top of the drying duct the dried sawdust was separated from evaporated moisture and cooled gases by a cyclone separator of 24 in. diam. Fig. 2 is a view of the drier installation.

## Results

***Effect of Gas-Flow Rate.*** Drier performance at a gas flow of 4180 lb per sq ft per hr is shown in Fig. 3. Drier performance at a gas flow of 6130 lb per sq ft per hr is shown in Fig. 4. Sawdust used in the tests had the particle-size distribution shown in Fig. 5 and was at an initial moisture content of 40 per cent (wet basis). All rates were reported on a basis of square foot of duct cross-sectional area to make the results more generally comparable.

A duct of about $13^1/_2$ in. diam has an area of 1 sq ft. Thus the numerical rates shown by the graphs are rates that would be expected for a drier duct of $13^1/_2$ in. diam. However, the $3^5/_8$-in-diam test duct had a cross-sectional area of approximately $^1/_{14}$ sq ft.

Efficiency, as mentioned previously, was defined as the heat going to water evaporated, divided by the total heat added. Moisture content was reported on the wet basis in all cases. Experience with the sawdust being dried indicated that air rates lower than 4180 lb per sq ft per hr would cause inadequate carrying velocity of the gas and consequent plugging of the drying duct. This factor influenced selection of the lowest air rate at 4180 lb per sq ft per hr. Gas velocity at 4180 lb per sq ft per hr and 600 F is 1870 fpm.

A comparison of Figs. 3 and 4 shows that higher efficiencies were obtained with the lower air velocity or air rate. Tests at higher air rates than reported in Figs. 3 and 4 showed further reduction of efficiencies, indicating the lowest air rate was the most desirable. At a rate per square foot of duct area per hour, of 4180 lb of gas at 800 F and 3000 lb of sawdust, maximum efficiency of 78 per cent was obtained.

***Effect of Temperature.*** There was no marked difference in maximum efficiencies obtained at the various initial gas temperatures as shown in Figs. 3 and 4. Drier capacity, however, increased with higher initial gas temperatures. An increase in initial gas temperature from 600 to 1200 F more than doubled the maximum evaporative capacity of the drier.

***Effect of Initial Sawdust Moisture.*** The effect of initial sawdust moisture content on performance of the drier at an air rate of 6130 lb per sq ft per hr and an initial gas temperature of 1000 F is shown in Fig. 6. Highest efficiency, 68 per cent, was obtained with sawdust that had an initial moisture of 40 per cent. Slightly lower efficiencies were obtained with sawdust at 50 per cent initial moisture, and sawdust at 25 per cent initial moisture gave the lowest efficiency.

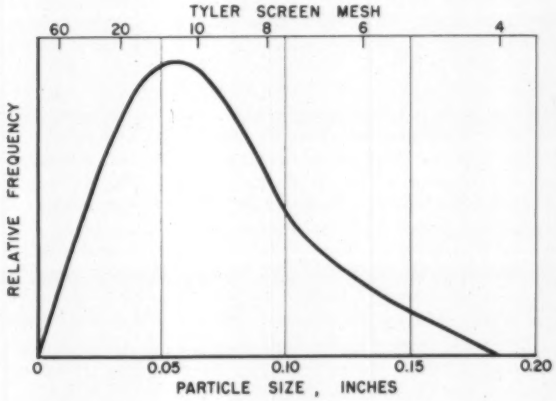



**Fig. 5 Typical particle-size distribution, by weight, of sawdust used in suspension-drying tests**

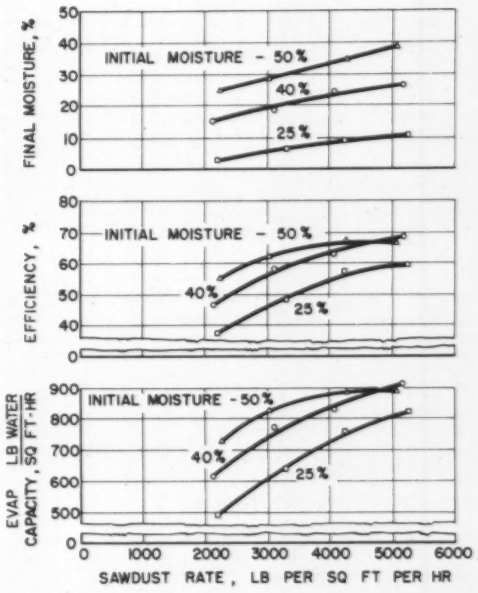



**Fig. 6 Effect of initial moisture on drier performance with 6130 lb of air per sq ft per hr and 1000 F gas**

An examination of Fig. 6 shows the benefit of drying in stages with the suspension drier. When drying from a high to a low moisture content, higher efficiency would be obtained by drying in two, or perhaps more, stages. It was found possible to dry from a high to a low moisture content with only one drying duct by mixing part of the dry output with the high-moisture incoming material. This procedure gave an intermediate moisture content for the mixture of recirculated and new material entering the drying duct. It was found that the moisture content of the mixture could be regulated by the proportion of dried to wet material introduced into the system.

## Conclusions

In the experimental sawdust suspension drier tested, maximum drier efficiencies of 70 to 80 per cent were obtained. Results indicated that suspension-drying is a practical and efficient method of drying small wood particles such as sawdust. Close control of the drying process was obtained readily by regulating drying variables.

Optimum gas velocity was found to be the lowest velocity that would convey the particles through the drying duct.

Results indicated that suspension-drying should be limited to materials with small particle sizes because drier capacity and efficiency dropped sharply as the particle size was increased.

***Acknowledgment.*** Grateful mention is made of work of Gale Gregg while a graduate student in mechanical engineering at Oregon State College during the initial stages of the project.

# Investigating the Strength of Copper-Brazed Joints

*Answers to why copper-brazed steel joints produce shear strengths greater than that of the copper itself used in the process*

By R. C. Grassi,[1] I. Cornet,[2] and R. S. Berger[3]

Several investigators have studied copper-brazed joints, usually in order to improve the joints from the production standpoint. Many factors have been found to affect the strength of copper-brazed joints (1)[4]; the most important are the finish of the surfaces (2), clearance between mating members (3, 4), time of braze (4), heat-treatment after brazing (3, 4, 5), contamination of surfaces (4), and atmosphere environment (4, 6).

### Ultimate-Shear-Strength Theories

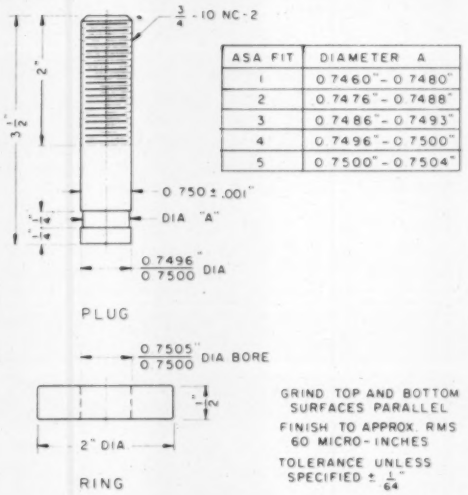
The ultimate shear strength of copper is 20,000 psi; copper-brazed joints commonly produce nominal shear strengths of over 30,000 psi. Several theories have been advanced to account for this apparent increase in strength of copper-brazed steel joints. The most widely accepted theory is that alloying action between the copper-braze metal and the steel results in an alloy of greater strength than that of pure copper (3, 7). Hanson and Ford (8) investigated the strength of copper alloyed with iron and found that the tensile strength varies from 32,000 psi, for a 0.2 per cent iron alloy to 49,000 psi for a 2.09 per cent iron alloy. The tensile strength for annealed copper is 32,500 psi and the shear strength is 20,000 psi (9).

Another theory proposed for the increase in strength is that the grain growth of the steel causes interlocking of the steel grains which thus act as points of interference during a shearing fracture (7). A modification of this theory is that the grain growth of the steel causes the steel grains to project into the copper braze and during fracture these projecting grains will compress the copper between them, producing a combination of shear and compression instead of pure shear in the copper.

It also has been suggested that the thin film of copper-braze metal between two pieces of a second and harder metal is constrained and cannot flow during fracture, thus increasing the strength of the joint (3).

***Materials and Procedure.*** Plain carbon steels (SAE 1018, 1020, and 1040) were used in the present investigation. Mating parts were of the same composition. Both pure copper and pure silver were used as brazing metals. Ring-and-plug test specimens are shown in Fig. 1. The rings were either reamed or bored on a lathe to obtain a surface finish of about 60 microinches.

Factors affecting the strength of the joints, such as brazing temperature, atmosphere, finish of the surfaces, machining, and cleaning of the specimens, and so on,




| ASA FIT | DIAMETER A |
|---|---|
| 1 | 0.7460" - 0.7480" |
| 2 | 0.7476" - 0.7488" |
| 3 | 0.7486" - 0.7493" |
| 4 | 0.7496" - 0.7500" |
| 5 | 0.7500" - 0.7504" |

**Fig. 1 Ring-and-plug test specimen of SAE 1018 and 1040 steels**

were controlled so that variations of strength or microstructure of the joints could be attributed to the variable being tested.

As excess braze metal was used, the fillets on the specimens after brazing were removed on a lathe using a special form tool to cut a sharp 90-deg angle between the ring and the plug. The specimens were machined so that the lower 1/4 in. provided concentricity for the upper 1/4 in. After brazing, the lower 1/4 in. was machined off leaving the upper class of fit section.

In order to observe the microstructure of the brazed joints, the end of a representative sample of each type of brazed joint was polished and etched and a photomicrograph obtained prior to fracturing. To evaluate differences between pushing a plug through a ring and pulling the plug through the ring, compression and tension shear tests were conducted. Both types of shear tests are reported in the literature.

***Effect of Brazing Time, Type of Test.*** A furnace temperature of 2000 F was selected, based on the literature and on the characteristics of the furnace available. A study of the effect of brazing time on strength using SAE 1020 steel specimens and ASA Class 4 fit is shown in

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[2] Associate Professor of Mechanical Engineering, University of California.
[3] Instructor, Marin Junior College, Kentfield, Calif.
[4] Numbers in parentheses refer to Bibliography at end of paper.
Contributed by the Metal Processing Research Committee and presented at a joint session of the Production Engineering and Metals Engineering Divisions at the Spring Meeting, March 18–21, 1956, Portland, Ore., of The American Society of Mechanical Engineers. (Slightly condensed.)

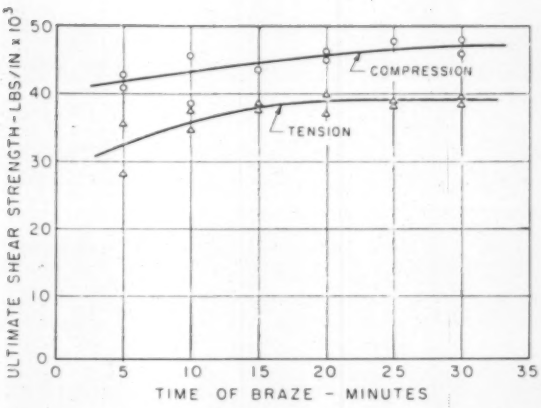



**Fig. 2 Ultimate shear strength versus brazing time of copper-brazed specimens. SAE 1020 steel, 1-in-diam specimens; class 4 fit; temperature, 2000 F**

Fig. 2. Initially, a plug was pushed through the ring as is commonly used for production-control studies. It was recognized that such compression tests produced a bulging of the plug at the joint, causing binding, and interfering with the separation. The area of braze and the area of the plug were critical—the braze area had to be small enough to force the fracture to occur in the braze and there was appreciable deformation in the ring. Consequently, a tension-type specimen was used.

The tension test as anticipated gave lower shear strengths than the compression test. A time of 20 min after the braze metal first melted, as determined by visual observation, at a furnace temperature of 2000 F was ample to obtain optimum shear strengths.

***Effect of Class of Fit.*** The effects of allowance on the shear strengths of copper and silver-brazed specimens are shown in Fig. 3. SAE 1040 steel was used, and all of the specimens were subjected to a 20-min braze at 2000 F. Allowances varied from ASA Class 1 through Class 5 fits and the data show that within this range of fits there is no significant variation in the shear strength of the brazed joint.

***Effect of Prior Grain Size.*** The effect of prior grain size on the strength of brazed joints was determined for SAE 1018 and 1040 steels in the as-received condition, and with grain size enlarged at 1800 F for 48 hr. The finer-grained copper-brazed SAE 1018 specimens had shear strengths from 30,800 to 35,500 psi; the coarser-grained copper-brazed SAE 1018 specimens had shear strengths from 35,200 to 37,100 psi. The finer-grained, copper-brazed SAE 1040 specimens had shear strengths from 32,400 to 36,400 psi; the coarser-grained, copper-brazed SAE 1040 specimens had shear strengths from 31,400 to 35,100 psi. The average shear strengths of the copper-brazed joints were approximately the same for both types of steel and for both fine and coarse initial grain size. Representative photomicrographs obtained during the investigation are shown in Figs. 4 and 5. During brazing the grains enlarged from their initial size to a final grain size determined by the high brazing temperature, 2000 F, and the time involved, 20 min.

Some silver-brazed specimens had imperfect brazes, but it appears that the maximum shear strengths developed were independent of the initial grain size of the steel plug and ring.

***Copper and Silver Brazing Metals, and Examination Theories.*** To examine the role that solid solubility and similar metallurgical factors play in developing the shear strength of a copper-brazed joint, two brazing metals were used, namely, pure copper and pure silver. Silver has properties quite similar to those of copper, both being face-centered cubic in structure. They differ markedly in one important respect; silver will melt and flow on the surface of steel, but will not alloy with steel as copper does (8). Tests with silver-brazed specimens are shown in Fig. 3, and photomicrographs of representative silver-brazed joints are shown in Figs. 4(*a*), 4(*c*), 4(*d*), and 5(*a*).

It already has been noted from Fig. 3 that with allowances varying from ASA Class 1 through Class 5 fits, there was no significant change in the shear strength of the brazed joint in an SAE 1040 steel. The copper-brazed joints averaged 32,600 psi in shear strength; the silver-brazed joints averaged 16,840 psi. For comparison, pure copper has a tensile strength of 32,500 psi,

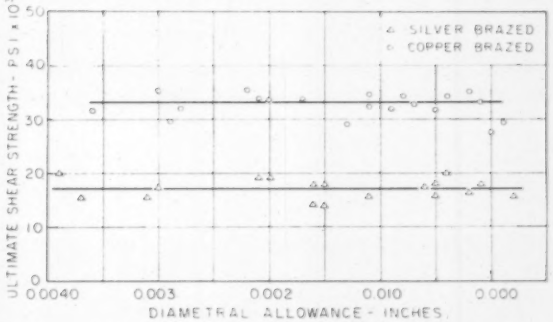



**Fig. 3 Ultimate shear strength versus diametral allowance, ASA class 1–class 5 fits. Copper and silver-brazed specimens of SAE 1040 steel; 20 min braze time; temperature 2000 F**

and a shear strength of 20,000 psi (9); pure silver has a tensile strength of 18,200 psi (10). Thus the copper-brazed joint develops 100 per cent of the tensile strength of pure copper; the silver-brazed joint develops 92.8 per cent of the tensile strength of pure silver. In each case the joint strength is much greater than the shear strength of the braze metal.

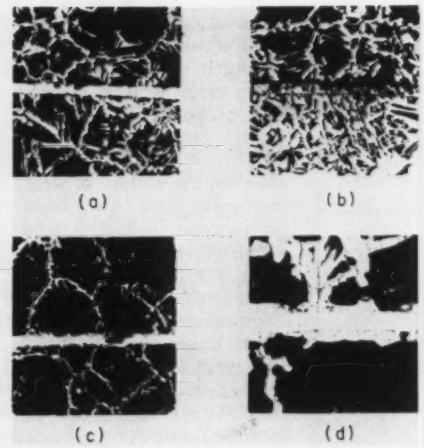
From the iron-copper phase diagram, it is reasonable to expect that iron will dissolve in the copper-braze metal and act as a hardening agent. The brazing time, 20 min, is long enough, at the high brazing temperature, 2000 F, to permit the alloying effect to contribute to the high shear strengths developed by copper-brazed joints. Hence it is particularly noteworthy that silver-brazed joints also develop relatively high shear strengths although iron is not soluble in silver and no alloying effect is present. The very thin film of braze metal (varying in thickness from 0.0039 in. to an interference fit of 0.0002 in.) gives a joint with a shear strength approximately equal to the tensile strength of the braze metal. These results agree with a theory advanced by Tylecote (3) that the film of braze metal is so thin that its work-hardening capacity is increased.

## Microstructural Features

Among theories proposed to account for the strength of copper-brazed joints there is the hypothesis that

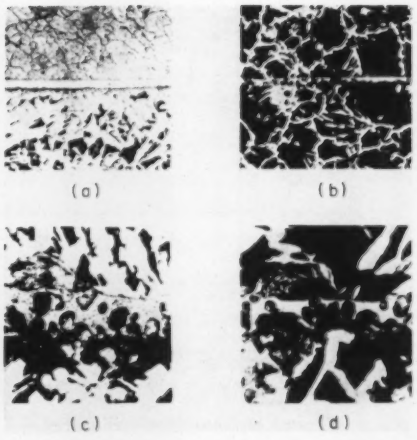
grain growth of the steel causes interlocking which gives interference during a shearing fracture (7); and also a modification of this hypothesis, that projecting grains of steel compress copper between them, producing combined stresses instead of pure shear in the copper. Such theories imply microstructural features which should be discernible in the photomicrographs of Figs. 4 and 5.

Figs. 4(*a*) and 4(*b*) show that previous grain size has almost no bearing on what the final grain size of the parent metal will be; the grains reach a maximum size for the temperature and time of brazing. In Fig. 4(*b*) is shown the decarburization of the plug which occurred during the grain-enlargement treatment of the SAE 1040 steel (the lower half of the photomicrograph is the plug).




(*a*) Brazed with pure silver, 2000 F for 20 min, ×100, nital etch.
(*b*) With enlarged grains, brazed with copper, 2000 F for 20 min, ×100, nital etch.
(*c*) Brazed with pure silver, 2000 F for 20 min, ×100, nital etch.
(*d*) Brazed with pure silver, 2000 F for 20 min, ×450, nital etch.

**Fig. 4 SAE 1040 steel brazed with pure silver and copper**




(*a*) SAE 1018 brazed with pure silver, 2000 F for 20 min, ×100, nital etch.
(*b*) SAE 1040 brazed with copper, 2000 F for 20 min, ×100, nital etch.
(*c*) SAE 1040 with enlarged grains, brazed with copper, 2000 F for 20 min, ×450, nital etch.
(*d*) SAE 1040 brazed with copper, 2000 F for 20 min, ×450, nital etch.

**Fig. 5 SAE 1018 steel brazed with pure silver and SAE 1040 steel copper-brazed**

An interesting difference between the copper-brazed joints and the silver-brazed joints may be noted in the photomicrographs. The silver brazing causes a ferrite lining to form along the walls of the joint, and the boundary between the silver and the ferrite is sharp. It is rare when the silver bounds on any pearlite area and extremely rare when a grain of ferrite or pearlite will jut out into the silver braze. This apparently is attributable to the absence of alloying. Figs. 4(*a*), 4(*c*), 4(*d*), and 5(*a*) show the smooth sharp boundaries clearly.

It also will be noted that there is no flow of the silver into the grain boundaries of the ferrite.

Figs. 5(*c*) and 5(*d*) illustrate the bonding of the parent metals by interlocking and welding of the steel grains across the braze. This type of bonding was infrequent in occurrence in the brazes observed, and probably does not contribute significantly to the shear strength. In order to be certain the islands were not some copper-rich compound the specimens were polished and etched with $NH_4OH$-$H_2O_2$. The photomicrographs made of these specimens showed clearly steel grains jutting into the braze and copper in the grain boundaries.

## Conclusions

1 The shear strength of a copper-brazed steel joint depends significantly on design.

2 There is no significant variation in the strength of brazed steel joints with a change of ASA class of fit from 1 to 5, inclusive, for joints brazed with copper or with silver.

3 Initial grain size has little, if any, effect on the shear strength of copper-brazed joints.

4 The shear strength of a steel joint when brazed with silver is approximately 17,000 psi, and when brazed with copper is approximately 33,000 psi.

5 The high strength of a silver-brazed joint is indicative of a greater work-hardening capacity of the thin braze metal which is restrained from flow during fracture by the two mating steel parts.

6 The high strength of a copper-brazed joint may be attributed to a greater work-hardening capacity of the thin braze metal under restraint, in conjunction with an increase in the strength of the copper-braze metal due to alloying with iron.

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# Briefing the Record

## Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

### Nuclear Facilities Plant

PRODUCTION began recently in The Babcock & Wilcox Company Nuclear Facilities Plant, near Lynchburg, Va.—the first major facility in the nation erected entirely at private expense to manufacture and test nuclear fuel elements and related products for peacetime use.

The new plant is divided into two spheres of activity—a nuclear fuel-element fabrication unit and an experimental unit where reactor core components will be studied and tested.

The fabrication building has complete metal casting, rolling, welding, and machining equipment to turn out flat-plate-type fuel elements. Production has already begun here on a year's supply of fuel elements for the U. S. Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho. Delivery of the first 35 assemblies under this contract is scheduled for August of this year.

Babcock & Wilcox also has contracted to design, fabricate, erect, and test the nation's first privately owned nuclear steam generator for the Consolidated Edison Company of New York. Production of fuel elements for this reactor will begin as soon as final design details have been completed.

Initial operations in the new plant's experimental facility will be devoted to determining the nuclear characteristics of the Consolidated Edison reactor design. The first core assembly, made to one-quarter scale, will be tested at a power level which will seldom exceed the output of an ordinary flashlight battery. Thorium, which is converted to new reactor fuel as fissioning takes place, will be a component of fuel elements employed in tests here, representing the first nuclear use of thorium by private industry.

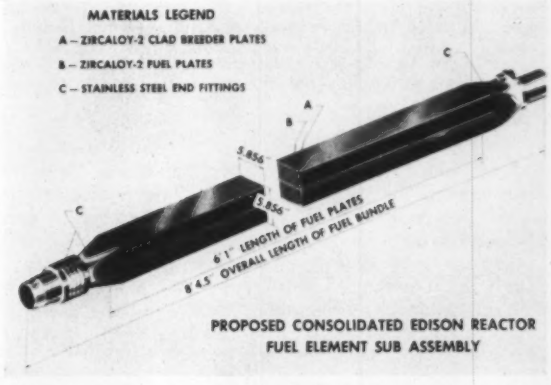
The experimental facility, which is 1200 yd from the fabrication building, is slated for completion in the near future. A reinforced concrete bay nearly three stories high, and with walls running to a thickness of three feet, forms the test chamber for critical assemblies. Space for offices, shops, a control room, laboratories, a vault, and other units has been built into a low wing of conventional construction adjoining the bay.

While early activities at the plant involve existing contracts, Alfred Iddles, Fellow ASME, Babcock & Wilcox president, pointed out that the entire unit has been designed to manufacture and test a broad range of present and future reactor and fuel-element types.

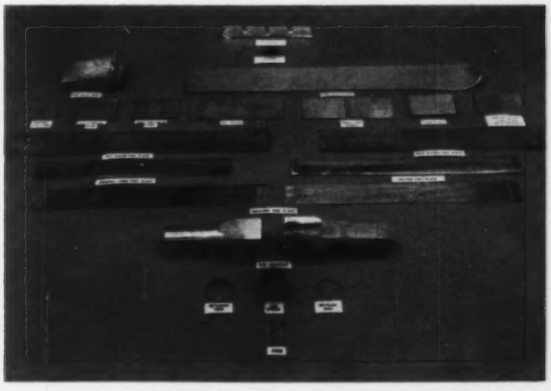
In planning the fabrication plant, he said, provisions were made to add the facilities necessary to make pin, rod, and cylindrical-type fuel elements, as well as the flat-plate types now in process.

Although materials used in making fuel elements here are not highly radioactive, special equipment has been built into the plant to prevent as much as possible human contact with even the most minute particles of these substances. At the same time, a broad "health physics" program, in which the science of physics supplements regular health and safety planning, has been instituted to protect employees and area residents.

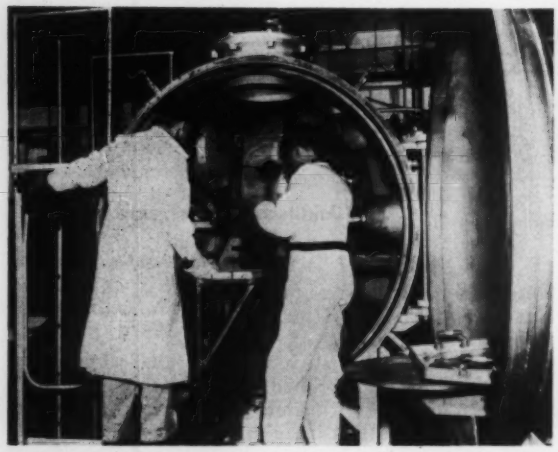
A reactor fuel element is made up primarily of fissionable material enclosed in a protective cladding. When the proper number of fuel elements are assembled into a reactor core, a critical mass is obtained. When a chain



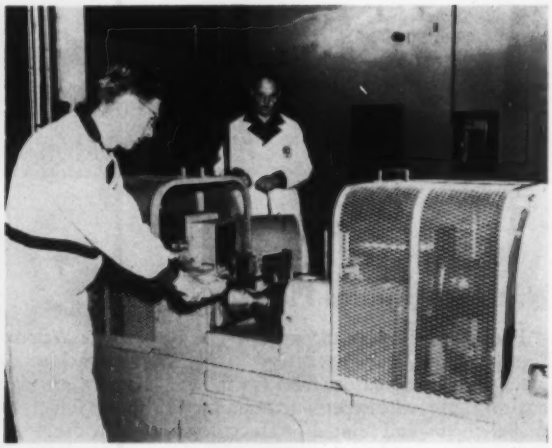

**This is one of the fuel-element designs proposed for use in a nuclear steam generator which The Babcock & Wilcox Company has contracted to desigh, fabricate, erect, and test for the Consolidated Edison Company of New York. Employing a "sandwich" of source and fertile materials, the elements will be produced at B & W's Nuclear Facilities Plant.**



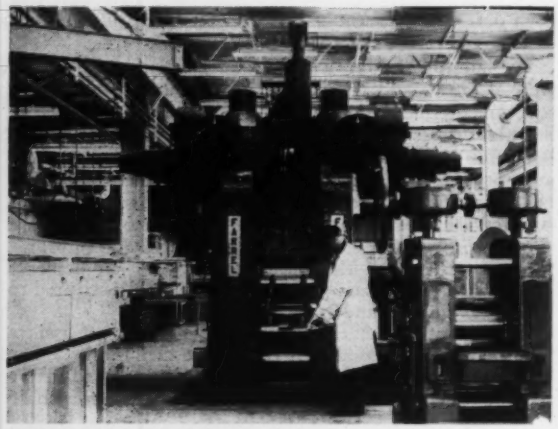
**View of main components of a nuclear reactor fuel element illustrates the complex melting, alloying, forging, rolling, machining, and other processes involved in nuclear production. Parts are from a fuel-element type now being made by B & W for the U. S. Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho.**



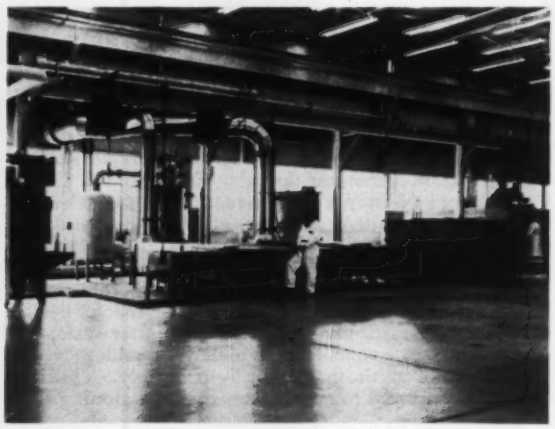
This induction melting furnace is used to produce alloys used in fuel-element fabrication. Furnace shown has a crucible capacity equivalent to 100 lb of steel and is water-cooled. Workmen here are completing a melt carried out in air. The equipment is also designed for melting in a vacuum.



Before being heated and hot rolled, arc-melted ingots are broken down to billets by this impacter. Ingots are positioned between dies of the impacter by means of guide roller, and unit is designed to deliver full energy of blow, or impact, to the work.



Materials for use in fabrication of nuclear reactor fuel elements are hot rolled on the small combination mill at *right,* or the larger mill in *center.* Prior to rolling process, materials are heated in salt bath unit at *left,* or in resistance furnace in *right background,* depending on nature of metal in use.



Fuel elements are pickled, rinsed, given a final running-water bath, and dried in this recovery area. Equipment includes (*front,* from *left*) a drying oven, pickling and rinsing tanks, a degreasing unit, and a vapor blaster. Floor of entire recovery area is lined with acid-resistant brick and slopes to a sump.

reaction (continuous fissioning) begins, atoms of fissionable material are partially converted from mass to energy in the form of heat. What is important is that this is a steady supply of heat which can be controlled and regulated.

A fuel-element assembly may also contain a fertile material such as uranium-238, or thorium, which is converted to fissionable material at the same time the chain reaction is taking place. Each fuel element for the Consolidated Edison nuclear steam generator comprises a "club sandwich" of plates that contain, alternately, thorium and uranium-235. During the chain reaction, a new fuel known as uranium-233 is made in the fertile thorium plates.

Plates of the MTR elements are an alloy of aluminum and uranium-235. This plant will also fabricate the fuel elements for the 5000-kw swimming pool research reactor which Babcock and Wilcox will build at Sao Paulo, Brazil.

Two major types of fuel elements are in use today. One is the rod, pin, or slug type, which may vary from 0.30 in. to 2.0 in. in diam and from 4.0 in. to 10.0 in. in length. An example of this form is the "natural uranium slug" measuring about 1.0 in. × 8.0 in. employed for producing plutonium.

A second type is the strip or plate form. It may vary from 0.01 in. to 0.35 in. in thickness, from 2.0 in. to 5.0 in. in width, and may be 2.0 ft to 15.0 ft long. The MTR fuel element, approximately 0.05 in. thick, 3.0 in. wide, and 30.0 in. long, is of the plate type.

All fuel elements being produced at Lynchburg are clad with protective coating, usually of aluminum, zirconium, or stainless steel. This cladding prevents local "hot spots," corrosion, metal distortion due to irradiation instability, and the resulting escape of radioactively-hot fission gases, and also confines the solid fission products to the "meat" of the fuel. Elements must be designed with good heat-transfer characteristics, since heat from fissioning is concentrated in extremely small points at birth.

Because a defective fuel element could contaminate an entire reactor core and force a costly shutdown, manufacturing operations in Babcock & Wilcox's new plant are geared to extremely fine tolerances and intensive inspection. The high cost, strategic value, and potency of fuel-element components also demand an accountability system which constantly shows the disposition and location of materials down to 1/100th of a gram.

## British Nuclear Reactors

Two new research reactors (or atomic piles) are operating at Harwell, according to the May, 1956, issue of *The Steam Engineer* (London). They are ZEUS (Zero Energy Uranium System) and ZETR (Zero Energy Thermal Reactor), and are part of Britain's program for investigating different types of reactors. ZEUS has been built to check the nuclear calculations on which the design of the fast reactor being built at Dounreay in the north of Scotland depends, and in many essentials it is a full-scale model of the Dounreay reactor. A team from the industrial group of the U.K.A.E.A. and the group of Harwell scientists working on ZEUS have combined and are gaining experience of the running of a fast reactor.

Construction of ZEUS was first announced during the Geneva Conference last August. The cylindrical core of the reactor, which is roughly 20 in. in diam and 20 in. long, is made up of uranium; this uranium is very highly enriched in the rare uranium 235 isotope. Thus in ZEUS uranium is used as a fuel, whereas in ZEPHYR, the first fast reactor at Harwell, plutonium is the fuel employed. The core of ZEUS is surrounded by many tons of uranium in which plutonium is forced gradually as the pile runs. The amount of uranium 235 needed to permit the nuclear reaction to start was found to be close to the predicted value. The enriching of the uranium used in the core was carried out at the Atomic Energy Authority's factory at Capenhurst near Chester.

The reactor will be operated at a very low power level, only 100 watts, so that no cooling is required, although the rate of the nuclear reaction will be quite adequate for making all the necessary nuclear measurements. The design power for the Dounreay reactor is about 60 mw.

ZETR uses a nuclear fuel in solution and is intended to provide information about the quantities of fuel which will be required for large-scale reactors using such solutions. Plutonium has already been studied in this reactor; uranium 235 is being studied now and uranium 233 is to be studied later this year. Natural water is used as a solvent at present, but in the summer heavy water is to be used.

Other reactors operating at Harwell are GLEEP (Graphite Low Energy Experimental Pile) and BEPO (British Experimental Pile) in which the fuel is natural uranium rods in graphite; ZEPHYR (Zero Energy Fast Reactor) with plutonium as fuel, in which it has been shown that two atoms of fissile material can be created for each one burned; and DIMPLE (Deuterium Moderated Pile Low Energy) in which the fuel is contained in heavy water. In addition, there are three other reactors under construction. These are DIDO and PLUTO, both powerful research tools in which the fuel is contained in heavy water, and LIDO, a "swimming pool" type of reactor in which the fuel elements are in a tank of ordinary water.

## French Nuclear Science

According to *France Actuelle*, May 15, 1956, a recently published report of the 18-nation Organization for European Economic Cooperation (OEEC) cited France and the United Kingdom as having made most of the effort toward creation of a European nuclear-energy industry. The OEEC study stated that in 1955, the number of technicians employed in nuclear energy work in France was 1900, compared to barely 1000 in all other OEEC countries on the European continent. As to budgets, the OEEC reported that "while the U. S. devoted about 0.5 per cent of its national income in 1955 to nuclear energy for military and peaceful purposes . . . France allocated hardly less than half this percentage for peaceful purposes alone."

### Current Program

The program adopted by the French Government for industrial nuclear research and power development in the years 1956–58 is expected to cost 100.71 billion francs ($287,743,000). It calls for the following:

1 Extension of industrial facilities for elaborating the worked materials (uranium metal, heavy water, etc.);

2 Intensification of industrial accomplishments, especially in construction of new graphite piles and chemical treatment plants;

3 Development of atomic motors for ship propulsion;

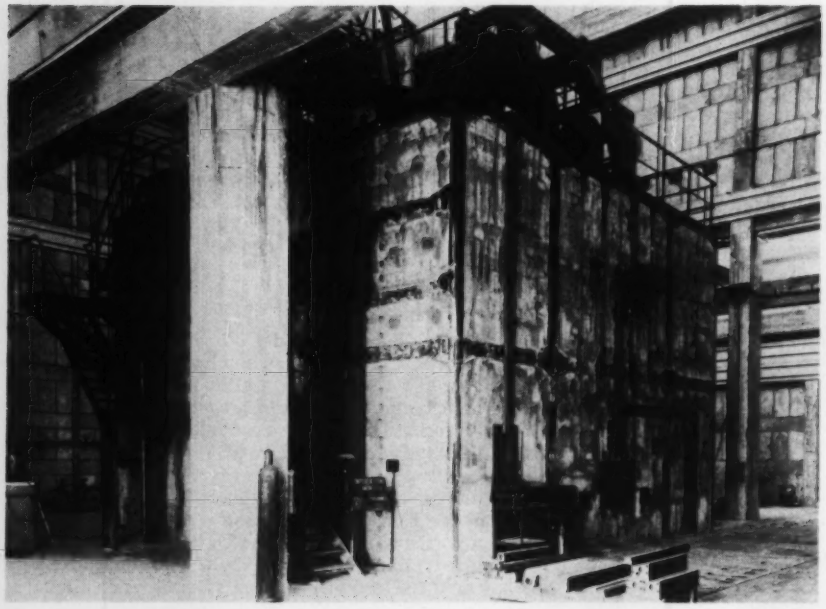
4 Continuation of basic research, which will require new laboratories, the building of secondary reactors and special plant, and the improvement of existing research equipment.

### The Marcoule Center

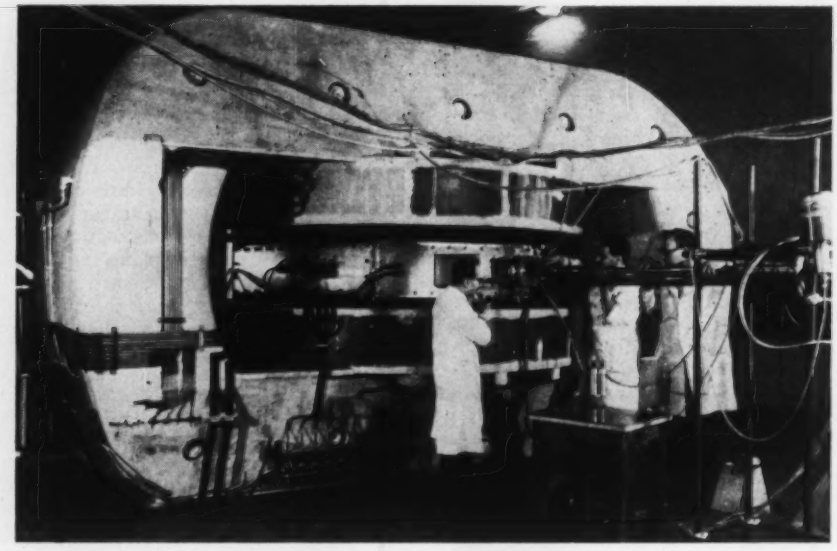
Plans for the first atomic power plant were worked out by the French Atomic Energy Commission in co-operation with four French companies—Râteau, Alsthom, Alsacienne de Constructions Mécaniques, and the Société des Forges et Ateliers du Creusot (Schneider), and also with Electricité de France.

Construction was begun in 1954 at Marcoule, on the right bank of the Rhone north of Avignon. The location was selected because this stretch of the Rhone links the Lyons industrial district with the large group of factories around Marseilles on the Etang de Berre, and because the "classified area" involved would not entail serious loss for French agriculture or industrial production.

The first Marcoule Pile G1 already is in operation with a power of 40,000 kw heat and an experimental generator which is producing roughly 5000 kw of electric power.



Pile P2 at the Saclay Nuclear Research Center. This pile was brought into operation in 1952 and is now producing the heat equivalent of 2400 kw. It uses natural uranium as fuel and heavy water as the neutron moderator. (*Photo courtesy French Embassy Press & Information Division.*)



The cyclotron at the Nuclear Research Center at Saclay. (*Photo courtesy French Embassy Press & Information Division.*)

The center will include two other reactors, G2 and G3, each with a power of 150,000 kw heat. The three reactors together will produce some 60,000 kw of electricity a year as well as some 100 kg of plutonium.

### Euratom

*France Actuelle* also noted that France is co-operating in trying to create an atomic-energy pool among the six nations of the European Coal and Steel Community, and also in the framework of OEEC. Recently, the OEEC nations agreed to set up a committee to prepare the way for such an organization. Meanwhile, the Foreign Ministers of France, Belgium, Italy, Luxembourg, The Netherlands, and West Germany have been completing, in Brussels, a final report on "Euratom," the project for the six-nation supranational atomic-energy pool, for direct consideration by the governments of the countries concerned.

### New A-Center at Grenoble

No matter how this joint West European endeavor develops, Francis Perrin, French High Commissioner for Atomic Energy, has declared that "France's preponderant position in Western Europe must not be lost." For,

"it is essential that France's membership in Euratom not be allowed to slow down the progress of atomic development in France."

Toward this purpose, Perrin has announced that a new atomic center is to be built at Grenoble, in the French Alpine region, where it will be closely associated with the University of Grenoble. This center will have an experimental atomic pile and employ 300 technicians.

### The French Example

The OEEC survey also points out that a prime factor in any improvement of Europe's nuclear-energy position, beyond the British effort, "is the wide scope of the French projects." And, perhaps in anticipation of Euratom, or at least of an OEEC research laboratory to be set up somewhere in Europe, the official 18-nation report says that "the French Atomic Centers at Saclay and Chatillon might serve as a guide . . .

"In 1955, the two centers were employing a total staff of 1900 including 360 highly specialized engineers and 400 technical assistants competent in the various technical branches of nuclear energy.

"The two centers include two experimental reactors, one of 150 and the other 2000 kw. A 15,000 kw materials-testing reactor is under construction there, as well as two or three small reactors of zero capacity.

"Up to the present, $43 million has been invested in these two centers. The operating costs for 1955 were $10 million. The materials-testing center will cost about $11.4 million . . ."

### Training for Atomic Industry

A singularly advanced training system is in operation in France for development of personnel for the atomic-energy industry. According to the OEEC survey, the following courses are given at the Saclay Nuclear Research Center:

1 Theoretical and experimental nuclear physics. These highly scientific courses are designed to provide nuclear physicists, who are already university-trained, with the additional knowledge normally required of nuclear engineers. In 1955, 112 students (105 French and 7 foreign) attended this course.

2 Nuclear engineering. In principle, the training of nuclear engineers at Saclay covers the same ground as at Harwell (in England). The procedure is somewhat different, however, as it covers two categories of students: first, the so-called "independent" students, who only take the three or four months' course, and second, the trainees, properly so-called, who supplement the course by working for about 2 months in the various departments of the Saclay Center. At the end of this period, they are required to work out the preliminary project for a reactor, which must be completed in about 3 months. Trainees . . . can obtain a State diploma, after submitting a thesis on their project. Owing to the length of the course, only one is held each year. In 1955, 42 trainees (all French) and 80 independent students, including 3 foreigners, were registered at Saclay.

3 Use of radioisotopes. In 1955, 80 students, including 25 foreigners, were enrolled.

4 Use of radioisotopes in medicine and biology. This course is to begin shortly; about 20 students are expected.

## Engineering College Enrollments

ENGINEERING college enrollment has increased for the fourth consecutive year—after successive annual declines from a post-World War II high of 244,390, in 1947 to a post-World War II low of 147,694 in 1951, according to a report by William A. Jaracz and Henry H. Armsby which appeared in the *Journal of Engineering Education*, February, 1956.

Mr. Jaracz is Head, Statistical Services Section, Research and Statistical Services Branch, Office of Education, U. S. Department of Health, Education, and Welfare. Dr. Armsby is Chief for Engineering Education, Division of Higher Education.

There were 211,923 engineering students enrolled (at all levels) in institutions accredited by the Engineers' Council for Professional Development in 1955, or 13.1 per cent more than were enrolled in such schools in 1954. This constitutes a considerable increase—larger, in fact, than that experienced by higher educational institutions in general. Total enrollment in all institutions of higher education increased 8.8 per cent, and male enrollment, 11.4 per cent. The 1955 increase of 13.1 per cent continues the trend in the direction of an annual increase in the rate of increase in engineering enrollment. The 1954 enrollment exceeded that of 1953 by 9.1 per cent; the percentage increases in 1953 and 1952 were 8.4 and 7.3, respectively. Engineering enrollment (at all levels) increased by about one-third (33.7 per cent) from 1952 to 1955.

### Enrollment of Freshmen

The freshmen enrollment gain made by engineering schools (10.1 per cent) is considerably larger than that experienced by higher educational institutions, generally (7.3 per cent). This difference, however, becomes less pronounced when the 10.1 per cent increase in engineering freshmen is compared with a 8.7 per cent increase in the first-time male enrollment in higher educational institutions as a whole. Inasmuch as engineering enrollment is predominantly male, sufficient justification exists for comparing enrollment in engineering schools with the male enrollment in all higher educational institutions.

The increase of 10.1 per cent in the enrollment of engineering freshmen in 1955 takes on considerable significance because the number of engineering freshmen increased at a declining rate in the three previous years. The increase in 1952 was 34.3 per cent; in 1953, 14.5 per cent; and in 1954, 5.8 per cent. Hence, not only was the increase in the enrollment of engineering freshmen almost twice as great in 1955 as in 1954, but also it put a halt to the decline in rate of increase.

### Undergraduate Enrollment

Undergraduate engineering enrollment, as is true of engineering enrollment generally, increased for the fourth consecutive year. The 190,355 undergraduate engineers enrolled in 1955 represented an increase of 13.9 per cent over the undergraduate engineering enrollment in 1954. Because the increases had been 7.6 per cent, 8.9 per cent, and 11.1 per cent, respectively, for the three years 1952 to 1954 inclusive, it is apparent that undergraduate engineering enrollment has been increasing at an increasing rate.

The undergraduate engineering enrollment was distributed by class level, in terms of percentages, as fol-

lows: 32.1 per cent were freshmen; 23.0 per cent, sophomores; 18.2 per cent, juniors; and 14.6 per cent were seniors. Students in the fifth year of 5-year programs accounted for 1.2 per cent of the undergraduate engineering enrollment; and the remaining 10.8 per cent were part-time and evening students.

Almost three-fifths (57.5 per cent) of all undergraduate engineering students were enrolled in three of the engineering curricula: electrical (24.1 per cent), mechanical (20.9 per cent), and civil (12.5 per cent). The corresponding figures for 1954 were 56.0 per cent for the three curricula combined, 22.1 per cent for electrical engineering, 21.0 per cent for mechanical, and 12.9 per cent for civil.

### Unclassified Undergraduates

Of the total undergraduate enrollment, 16.2 per cent consisted of students who were unclassified with respect to the particular engineering discipline they planned to pursue. In 1955, 94 schools reported a total of 30,779 unclassified students. The same number of schools reported unclassified enrollment in 1954, and such enrollment constituted approximately the same proportion (16.3 per cent) of the total undergraduate enrollment. The greater part of such students are found in the freshman class and among the evening students. In 1955, 31.9 per cent of the freshman class and 44.3 per cent of all undergraduate evening students were unclassified.

### First Degrees

The number of male students who earned undergraduate engineering degrees in 1955 was 2.5 per cent larger than the number in the previous year. This increase compares favorably with a decline of 9.1 per cent in the number of male undergraduates granted engineering degrees in 1954, and with the decline of 2.1 per cent in the number of first degrees conferred on male students in all institutions of higher education in 1955. Of all first degrees granted to male students by all degree-granting institutions in 1955, 11.0 per cent were in engineering. The 1955 ratio appears to have stopped a trend in the direction of increasingly smaller ratios which had prevailed in the three previous years: 11.9 per cent in 1952, 10.8 per cent in 1953, and 10.5 per cent in 1954.

The number of first engineering degrees declined annually from the peak year 1950, when 48,160 were conferred, to 1954, when 19,707 were conferred. This situation reflected the decline in freshmen enrollment after 1946. The small number of first engineering degrees conferred in 1954 can be attributed to the fact that the entering freshman class of 1950 was the smallest in the post-World War II period. The 1955 increase in first engineering degrees is expected to be an annual occurrence for the foreseeable future; i.e., such increases will reflect the annual increase in freshmen enrollment subsequent to 1950.

In 1955, almost two-thirds (65.9 per cent) of all first engineering degrees were conferred in three fields of engineering: 26.0 per cent in mechanical, 22.3 per cent in electrical, and 17.6 per cent in civil. Mechanical and electrical engineering showed increased strength, while civil engineering declined somewhat in relative importance. The corresponding figures for 1954 were 63.5 per cent for the three curricula combined; 24.5 per cent for mechanical, 20.7 per cent for electrical, and 18.3 per cent for civil.

### Graduate Enrollment

Every post-World War II year, with the exception of 1954, has witnessed an increase in graduate engineering enrollment. In 1954, there was a net decline of 1055 graduate students—resulting from an increase of 278 students enrolled in work leading to a doctoral degree, and a decline of 1333 students enrolled for work leading to a master's or other predoctoral degree. In 1955, on the other hand, there was a net increase of 1217 graduate students—resulting from an increase of 1335 enrolled for work leading to a master's or other predoctoral degree, and a decline of 118 students enrolled in work leading to a doctoral degree.

A considerable, but declining, proportion of students working for a master's or other predoctoral degree were evening students. The proportions for the last four years were the following: 57.4 per cent in 1952, 56.1 per cent in 1953, 51.4 per cent in 1954, and 48.7 per cent in 1955. A considerable smaller proportion of doctoral students were evening students. This proportion declined considerably in 1955, after small annual increases in the three previous years. The proportions for the last four years were the following: 22.8 per cent in 1952, 23.4 per cent in 1953, 24.3 per cent in 1954, and 16.1 per cent in 1955.

The increase in graduate engineering enrollment in 1955, following a decline in 1954, is gratifying in view of the great demand for engineers with advanced educational attainment. The large proportion of graduate engineering students who attend classes during the evening indicates an awareness on the part of practicing engineers of the necessity for bettering their understanding of the complex engineering processes which are constantly being developed.

### Graduate Degrees

The 7.6 per cent increase in the number of master's degrees conferred in engineering is considerably greater than the 2.4 per cent increase in master's degrees conferred by all degree-granting institutions. This increase, although smaller than that in 1954 (11.4 per cent), constitutes a considerable change from the situation which prevailed in 1952 and 1953, when the number of master's degrees declined.

There was an increase of 1.5 per cent in the number of engineering doctorates conferred. In actual numbers: 599 were conferred in 1955, as compared with 590 in 1954. The number of doctorates conferred by all institutions of higher education, on the other hand, declined 1.7 per cent.

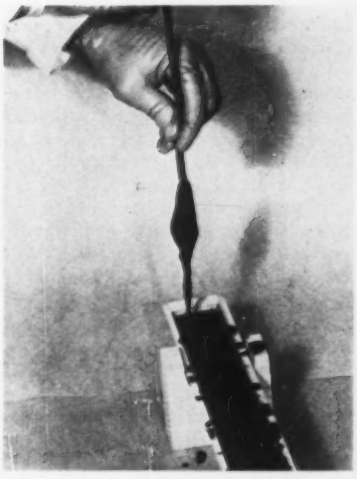
## Plastic Springs

A PRACTICAL procedure for mass-producing plastic springs has been developed by the National Bureau of Standards in work sponsored by the Army Ordnance Corps. Springs formed in this way from glass fiber-reinforced resin have desirable mechanical properties for a wide range of applications. Until now plastic springs have been little used because suitable techniques for making springs of the types needed have been lacking.

Polymeric materials, such as plastics and rubbers, have a number of inherent advantages for use in springs for special purposes. For example, they are nonmagnetic and have low electrical and thermal conductivity. They

A

B



C

D

E

F

**In the National Bureau of Standards' procedure for making plastic springs, the first step is to soak a "rope" of glass fibers in a resin solution (A). A piece of piano wire is tied to one end of the rope and run through a section of plastic tubing. The resin-soaked glass-fiber rope is drawn into the plastic tubing (B), and the excess resin solution is squeezed off (C). The tubing is then wound around a mandrel to form a helix (D), which is placed in an oven for curing (E). After curing, the plastic tubing is removed, leaving the finished spring. Creep test (F) of an NBS plastic spring under load. The spring deflection is measured on the dial indicator while the applied load is read from the dial in the operator's hand.**

can be molded directly to dimensions without the development of any considerable internal stress. Their high corrosion resistance should make them of value for applications in chemical plants and installations subject to acid fumes or to salt air. Other applications may benefit from the strength-to-weight ratios of plastics, which are often higher than those obtained with spring-making metals. Also, the broad range of transparent and colored materials that can be used makes striking decorative effects possible.

The plastic springs are molded by drawing resin-soaked glass fibers through vinyl copolymer tubing and wrapping the loaded tubing in a helix around a mandrel. After curing in an air-circulating oven, the tubing is removed, leaving a solid plastic spring reinforced with glass fibers.

The most successful procedure uses vinyl chloride-vinyl acetate copolymer tubing having a $^1/_4$ or $^3/_{16}$-in-ID and a $^1/_8$-in. wall thickness. Lengths of glass rovings are formed into a loose yarn, without twist, which is then doubled back to make a U-shaped bundle. This bundle is placed in a trough partly filled with liquid resin and is immersed until thoroughly soaked. A steel wire is threaded through the tubing, attached to the bend in the U-shaped bundle, and used to pull the bundle through the tubing. Considerable force is applied to the wire by means of a small windlass.

When the tubing is completely filled, the wire is dis-

connected and the ends of the tubing sealed with hose clamps. The tubing is wound on a mandrel and the entire assembly is placed in an oven for curing under the conditions specified by the resin manufacturer. After removal of the tubing, post curing is performed as required, and the springs are cut and ground to the finished length.

Of the resins studied, the most promising were epoxides and polyesters. These resins are better suited for spring applications on the basis of torsional moduli, temperature sensitivity, and ease of handling. In general, the polyesters are more sensitive to elevated temperatures than the epoxy resins, but the epoxy materials vary widely in this respect.

Springs made from polyester resins with glass fiber reinforcement showed good energy recovery properties after short periods of storage at −40 F, but, these properties were adversely affected by 13 days' exposure to 135 F while under stress. The best results were obtained with an epoxy resin cured with *m*-phenylenediamine. Springs made of this material had torsional moduli of rigidity of the order of $1.0 \times 10^6$ psi. In 2-in. lengths they deflected $^1/_2$ in. under a static load of 25 lb. Three-inch springs of this type retained 40 per cent of their original energy when compressed to their solid length and stored at 135 F for 13 days.

When the glass-epoxy springs were tested for recoverable energy a second time, higher values were invariably obtained. This characteristic "work tempering" of the epoxide resins was also demonstrated in torsion tests on nonreinforced plastic rods. An improvement of as much as 120 per cent over the original available energy was indicated. Preloading the epoxide spring during storage or within 30 days before use would make it possible to utilize this property of the material.

The mechanical and thermal properties of the plastic springs can be varied widely by proper choice of materials and dimensions. For example, stiffer and probably more brittle springs result when the glass content is increased. At the same time, a high degree of homogeneity in static properties can be achieved. Under a load of 25 pounds, 100 of the epoxy-resin springs had an average deflection of 0.53 in. with a standard deviation of 0.05 in.

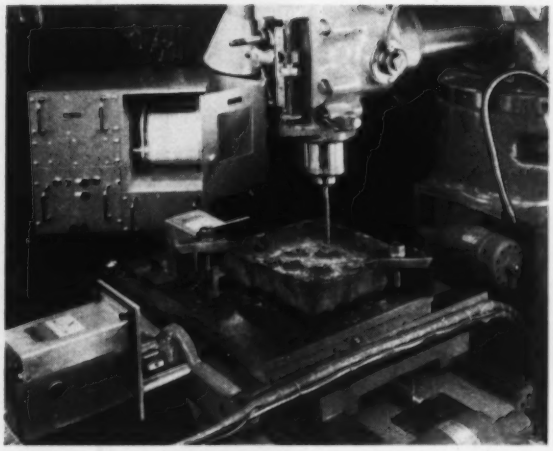
## Automatic Positioning Table

A NEW lightweight, low-cost Binotrol automatic positioning table that is ideal for repetitive runs in light manufacturing and small machine shops has been developed by Barnes Engineering Company, Stamford, Conn.

The complete unit controls a 10 × 10-in. Master Model 12 table which is positioned in two axes to an accuracy of 0.001 in. The controls for the table are compactly packaged in a $16^3/_4 \times 15^5/_8 \times 10^1/_2$-in. console weighing under 60 lb. The entire unit, table and all, fits easily on an ordinary work bench and sells for $5000.

A Binotrol punched-tape system controls the table. In this system, all operating instructions are punched on a tape, and the Binotrol system "reads" the tape and controls the motion of the table.

The table can be used in combination with a drilling machine, miller, or any other common machine tool to ream, sink, tap, mill, screw, or perform any of the usual machine-shop operations. The entire sequence of operations is permanently preserved on the tape, which can be filed away and reused at any time.



**Binotrol automatic positioning table manufactured by Barnes Engineering Company is ideal for repetitive runs and light manufacturing**

Preparing a tape is a relatively simple task that demands only a knowledge of the most efficient sequence of operations for the machine. Unlike a human operator, the tape feeds the same signal to the machine at each time; hence the human factors of fatigue, carelessness, etc., are eliminated and the machine will always perform within its specified accuracy.

In operation, the positions of the two lead screws are continually being compared with the required positions as indicated by the punched tape. When there is a difference in position, a voltage is applied to two motors, one for the *X* and one for the *Y* position, which drive the lead screws to the required, or zero difference, position.

Future models of the table will incorporate printed circuitry, thereby reducing the size and weight of the control console by at least one-third. The same control system can be applied to a table of larger size, and signals may be fed into the machine manually, as well as by punched tape, if desired.

## Pile Hammer

A FREE-PISTONED, diesel-powered pile hammer was demonstrated recently for the press by McKiernan-Terry Corporation at Dover, N. J. It compares favorably with this company's steam-powered pile drivers both operationally and economically and has the additional features of being completely self-contained, light, mobile, and versatile. Requiring neither a steam boiler nor an air compressor, it is particularly suited for use where a mobile, fast-moving driving rig is required and where a steam generator would be inconvenient.

The energy produced by the diesel pile hammer is comparable to that available from a steam driver of like size. It is measured by the weight of the ram times the number of feet the ram falls. The weight of the ram in the present model is 3000 lb, and McKiernan-Terry plans to manufacture models with rams weighing 2000 lb and 4000 lb. The ram moves an average distance of 6 ft; the distance it moves is determined by the resistance offered by the pile. The harder the drive, the

greater the stroke, and the greater the energy produced. Consequently, maximum energy is obtained when the driving is most difficult. The piston is free-falling.

The DE 30 (3000-lb) hammer delivers 45 to 55 strokes per minute with an average force per blow of 18,000 ft-lb. Operational tests show that the pile driver operates most efficiently with one to two-ton piles at a bearing of from 40 to 90 tons.

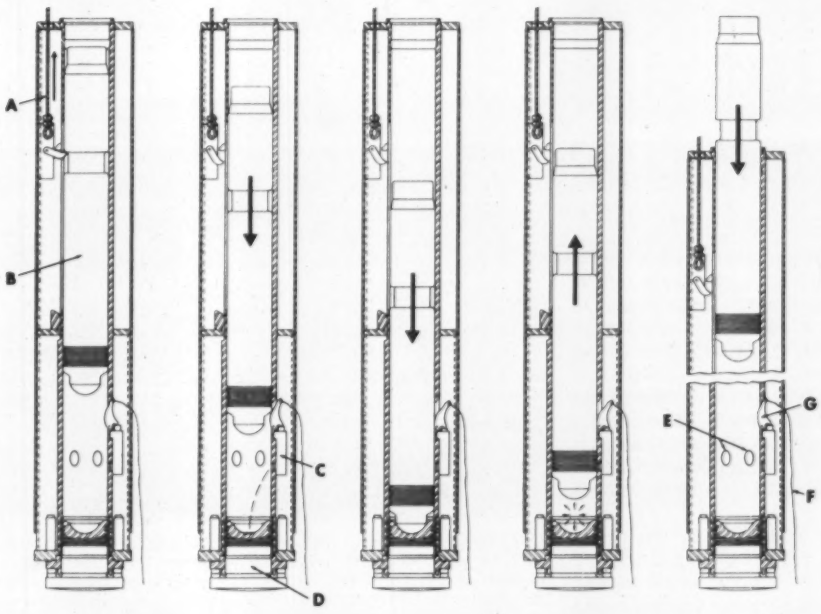
Operation of the DE 30 is simple. The hammer, shown in the accompanying drawing, is worked by a single load line (A) from a 30 to 35-ton crawler or truck crane. It is started merely by lifting the ram (B) with the load line and allowing it to fall. Once started, the hammer operates at a speed and stroke determined by the pile resistance.

During the downstroke, the ram actuates a metering pump (C) that delivers a measured amount of liquid fuel which falls into a pocket in the anvil block (D). When the ram strikes the anvil block, the fuel is atomized by the impact blow and then ignited by the heat of compression of the air caused by the falling ram. The resultant explosive force drives the ram upward and the anvil downward, adding a pushing effect on the pile that combines with the impact blow given as a result of the ram's striking the anvil. In this way self-timing is achieved by heat of compression and the impact atomization of the fuel by the ram.

During the upward travel of the ram, exhaust ports (E) are opened, through which exhaust gases are scavenged. When the ram reaches the top of its travel, it starts to fall, closing the exhaust ports. The driving cycle is then repeated. The hammer is stopped by pulling a rope (F) disengaging the fuel pump cam (G).

A single load line operating on a 1-cu-yd truck or crawler crane is used for hoisting and lowering the entire hammer. This load line is the only external connection to the hammer. It is attached to a built-in trip mechanism used for engaging, hoisting, and dropping the ram for the starting cycle. This trip mechanism prevents the ram from jumping out of its cylinder whenever the ram meets a heavy resistance.

**A workman is shown stopping the action of a McKiernan-Terry DE 30 diesel hammer, in operation on a highway job for the Macco Corporation, Paramount, Calif., by pulling a rope that disengages the fuel-pump cam**




**Schematic drawing of McKiernan-Terry self-contained diesel pile hammer, illustrating one entire cycle of operation**

Incorporating built-in fuel and lubricant reservoirs, the hammer operates on a minimum of fuel. Sufficient capacity for over three days of economical operation without refilling is provided by the 25-gal fuel tank and 5-gal lubricant tank which make refueling stops infrequent. The DE 30 uses about 8 gal of fuel and $1^1/_2$ gal of lubricant a day.

A forced-lubrication system provides a continuous flow of lubricant to the wearing surfaces, and high-wear surfaces are plated with porous chrome for

long life. A laminated rubber cushion ring minimizes shock to the cylinder-mounted pumps and pressure lines.

The diesel pile hammer is assembled easily with a minimum of parts. Both cylinder and ram are of one-piece construction, and all parts subjected to high-shock stresses are made of special alloy steels to reduce the possibilities of breakage. Maintenance costs are low, and operating efficiency is increased by the ease of handling.

A minimum of pile damage results from the use of the diesel hammer. Heavy piling is driven with minimum hammer weight and maximum driving effort.

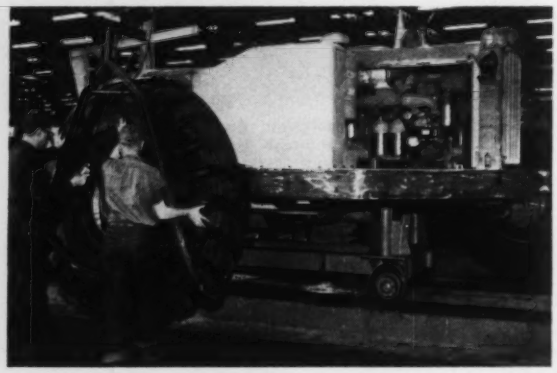
## Tractor Plant

THE world's largest motor grader and wheel-type tractor plant was dedicated in Decatur, Ill., recently by Caterpillar Tractor Company.

Built to accommodate the company's growing production of wheel-type tractors and motor graders and release facilities at Peoria for added output of crawler tractors and diesel engines, the new plant is situated on a 425-acre plot of land less than a mile northeast of Decatur.

The two main buildings provide more than 840,000 sq ft of manufacturing and office space.

The manufacturing building—730,400 sq ft in area—



**Wheel-tractor assembly line rises to permit tire installation without having to lift the machine. This 300-hp Caterpillar DW21 Tractor will be tested, then moved to paint booth for steam cleaning, one prime, and two finish coats.**

is double-walled and equivalent to two stories high all along its 830-ft width and its 880-ft length. Two assembly lines extend nearly the entire length of the plant.

Adjoining the front half of this building is the administration building which provides 53,581 sq ft of office space on two floors.

Flexibility of manufacturing operations is built in the new Decatur plant. Overhead clearances, for example, with the exception of extra height for heat-treat and 34-ft-high crane bays, are not tailored to specific operations. The entire manufacturing building has a minimum 20-ft clearance from floor to truss.

Other features that promote flexibility are the extra-long assembly lines to allow for possible addition of future models, an 8-in., unreinforced wood-block-covered concrete floor, which permits rearranging machines and special foundations with minimum effort, and the generous use of overhead Cleveland Tramrail. Office areas are made flexible by the use of Q-flooring and prefabricated steel partitioning.

Stretching through the north half of the manufacturing building for almost the entire length—800 ft—are the two assembly lines on which the Decatur-built Caterpillar machines will move into final assembly.

On one of the lines, the three motor-grader models, No. 12, No. 112, and No. 212, are assembled. The wheel-type tractors are assembled on the second line. These include the DW15, DW20, and DW21.

From the assembly lines, the machines move onto the final adjustment floor, then to the paint booth located adjacent to the north wall of the plant. There they are spray painted and readied prior to shipment out of the plant.

## Free-Piston Auto Engine

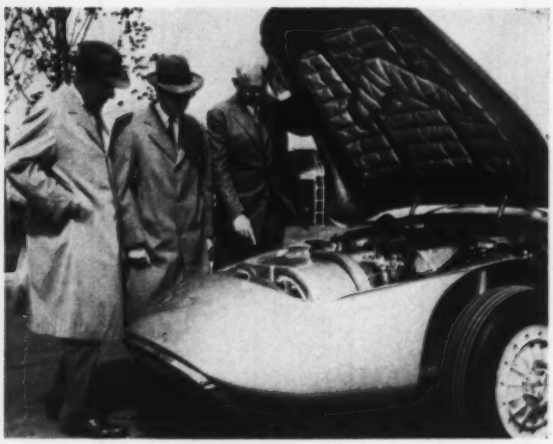
THE first automobile in the world, the XP-500, to be powered by a free-piston engine was unveiled at the May 15–16, 1956, dedication of the new General Motors Technical Center, near Detroit, Mich. (See pages 644 and 645.) Such engines have been under test for the past three years at GM.

The XP-500's engine has no crankshaft or connecting rods, no rotating parts in the manner of a conventional auto engine with its pistons spinning a crankshaft. Basically its pistons operate like a bicycle tire pump or old-fashioned fireplace bellows, blowing hot gases through a pipe to a turbine. The spinning turbine powers the rear wheels of the car.

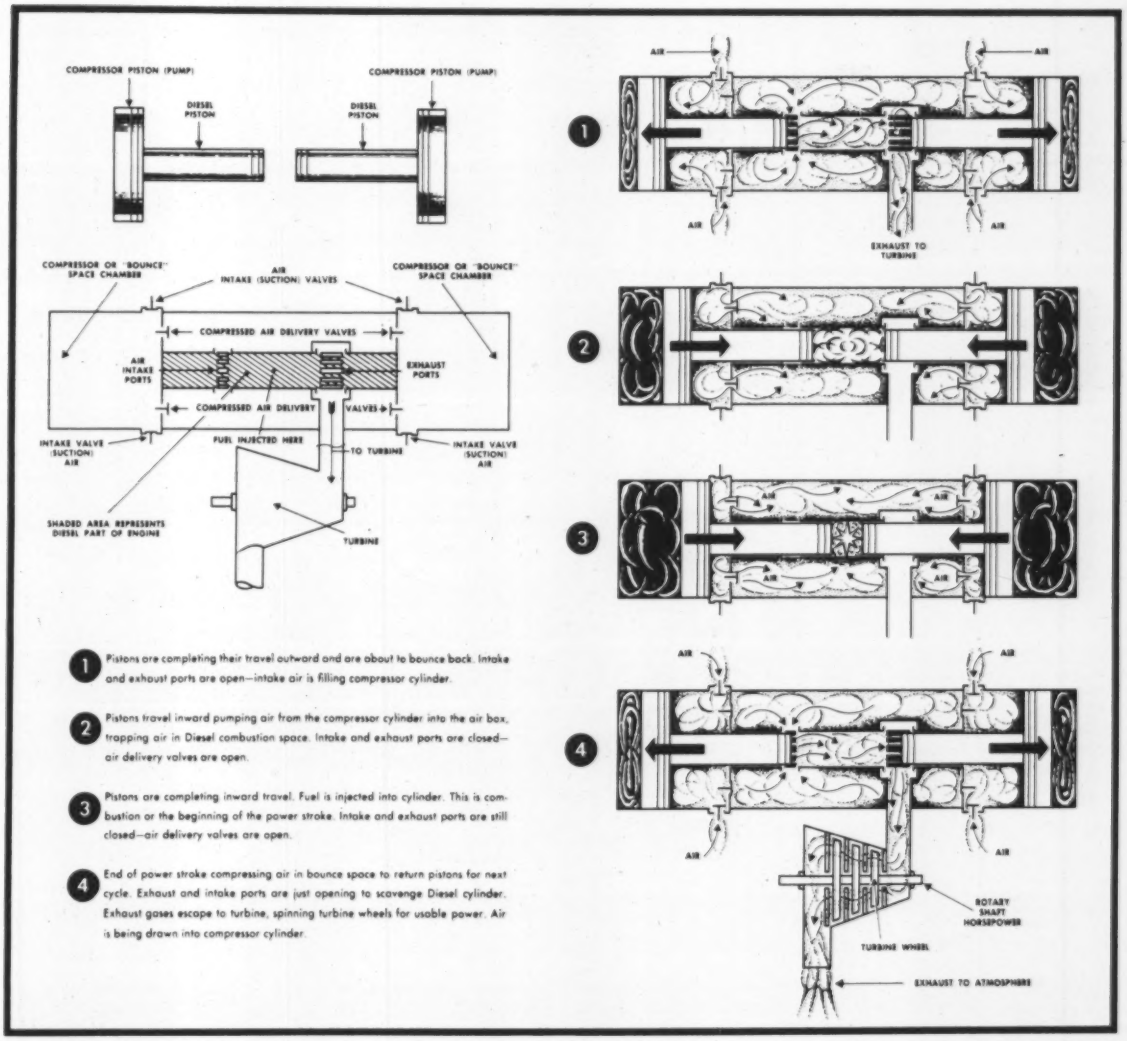
The free-piston engine generates a nominal 250 hp and is described as a Siamese unit.

This means it consists of two parallel cylinders, each containing a set of two horizontally opposed pistons, a departure from previous free-piston-engine design.

Heretofore this type of engine has been used primarily in Europe for such large-size jobs as powering ships, locomotives, stationary power plants, and portable air compressors. These units usually consist of a large



**C. F. (Boss) Kettering, Fellow ASME, *left,* a General Motors director and research consultant, examines the free-piston engine under the hood of the new experimental GM car XP-500 with Lawrence R. Hafstad, *center,* GM vice-president and director of the Research Staff, and Arthur F. Underwood, Mem. ASME, head of the Mechanical Development Department, GM Research Staff.**




1 Pistons are completing their travel outward and are about to bounce back. Intake and exhaust ports are open—intake air is filling compressor cylinder.

2 Pistons travel inward pumping air from the compressor cylinder into the air box, trapping air in Diesel combustion space. Intake and exhaust ports are closed—air delivery valves are open.

3 Pistons are completing inward travel. Fuel is injected into cylinder. This is combustion or the beginning of the power stroke. Intake and exhaust ports are still closed—air delivery valves are open.

4 End of power stroke compressing air in bounce space to return pistons for next cycle. Exhaust and intake ports are just opening to scavenge Diesel cylinder. Exhaust gases escape to turbine, spinning turbine wheels for usable power. Air is being drawn into compressor cylinder.

**Operating diagram of free-piston engine which is installed in General Motor's recently announced XP-500 automobile**

single cylinder or banks of disconnected single cylinders each containing two pistons.

An interesting feature of a free-piston engine is its ability to run on all types of mineral oils from high octane gasolines to so-called Bunker "C" or residual fuels.

In fact, a GM experimental unit has been fueled with whale, peanut, and other vegetable oils.

Although in an early experimental stage, the engine offers engineers many interesting possibilities with a new form of power not only for passenger cars but also for buses, trucks, and military vehicles.

It has few high precision parts as compared with conventional auto piston engines and gas turbines. Also, engineers say, it is inherently balanced so that it operates virtually without vibration, and the comparative absence of rotating parts would cause little wear of rubbing metals.

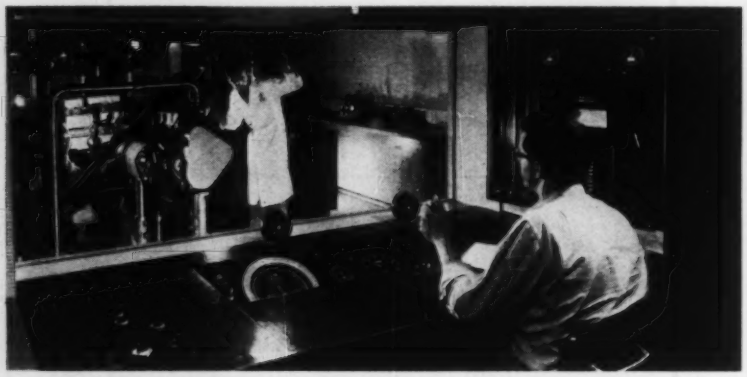
The pistons are arranged opposite one another in horizontal cylinders. An air-fuel charge fired between them—with injectors like a diesel—drives the pistons apart, compressing air at the ends of the cylinders.

The compressed air bounces the pistons back toward inner "dead center" and, as they travel inward, they also compress air that pumps into a diesel cylinder. The back-and-forth movement continues to compress air which is piped to a turbine.

Because these exhaust gases pumped to the turbine are relatively cool, no higher than 900 F, the turbine blades can be made of noncritical, nonstrategic materials.

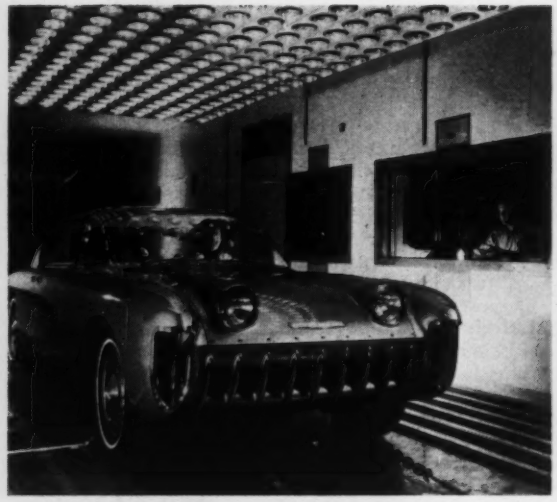
This feature also is attractive because gas-turbine engines, such as those in GM's Firebird I and II, use alloys that are relatively scarce and expensive.

In the XP-500 the free piston unit or "air pump" is under the hood. The pipe to the turbine runs along one of the car's side or chassis frames, thus giving the passenger compartment a "flat floor." In the rear compartment the turbine is combined with the transmission-axle unit, transmitting power to the rear wheels.



For off-the-road tests of both production and experimental auto engines, this is a typical dynamometer cell operated by General Motors Research Staff at GM Technical Center. Outside the cell itself is the instrument and control console. The 330-acre, 25-building Technical Center, dedicated on May 16, 1956, is GM's challenge to the technological advance of America.

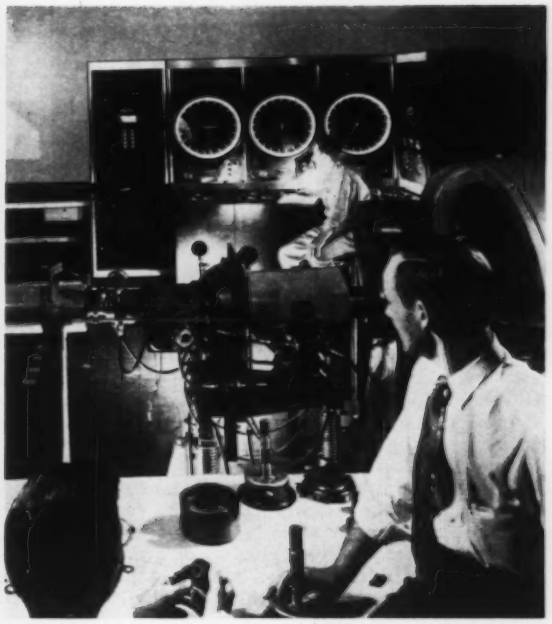
Equipped for virtually all types of experimental melts is this foundry operated by Metallurgical Engineering Department at the GM Technical Center. Like other special purpose areas at the Center, it features maximum flexibility. The technical center includes four central staff organizations—Research, Engineering, Styling, and Process Development. There is also a Service Section which maintains the buildings and grounds.



Interior view of Research Wind Tunnel building with Chevrolet Biscayne in test area on 200-hp chassis dynamometer. Airstreams up to 100 mph can be generated.

Temperatures down to —90 F can be obtained in the Center's Cold Test Laboratory. The LaSalle II, one of the GM "dream" cars, is shown here on the chassis dynamometer.

In this dynamometer room engineers are preparing to run a test in which the combustion can be photographed at high speed—more than 1000 pictures per sec—through a "window" in the top of a single-cylinder test engine.



This dynamometer test cell is used to evaluate automatic transmission gears by the research staff at the GM Technical Center. Shown on the dynamometer in the foreground is a Powerglide unit.

# General Motors Technical Center . . .

## . . dedicated to a "better tomorrow through research today"

One thousand gallons of water a minute swirls over this large flow table in the hydraulics laboratory at the Center. It courses through "straightening vanes," which can be seen in the foreground, and flows around oversize wooden turbine blades. From studies of flow patterns on this testing device, engineers of Engineering Staff's Transmission Development group can determine the best shapes for turbine-blade designs in automatic transmissions and torque converters for automobiles, trucks, and buses.

# European Survey

## Engineering Progress in the British Isles and Western Europe

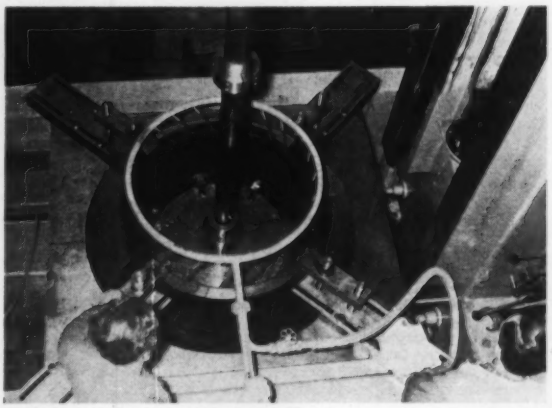
J. Foster Petree,[1] Mem. ASME, *European Correspondent*

### Honing Machine

WHAT is claimed to be the largest vertical honing machine in the world has been installed within recent weeks at the works of the Ingenieursbureau Lemet Chromium H. van der Horst N.V., at Hilversum, Holland. It was designed and made to their requirements by the Maschinenfabrik Gehring K.-G., of Stuttgart-Ruit, Germany, and has a vertical stroke of 4 m (13 ft 1 in.). It will hone cylinders up to a maximum bore of 800 mm (31 1/2 in.). For some years the firm has had in use a vertical honing machine, by the same makers, with a stroke of 2.65 m, which could be used for cylinders of greater stroke by fitting special spindle parts, but the adjustment took time. The new machine, which weighs 29 tons, will enable the largest cylinder liners to be honed without changing the spindle.

The workpiece carrier has a travel of 3 ft 11 1/4 in. to allow the center of the work to be brought into line with that of the spindle, which is 2 ft 11 7/16 in. from the column face. The honing head is fitted with an automatic sizing device which measures the bore while honing is in progress and, when the desired diameter is reached, stops the spindle and raises the head to the top of the stroke.

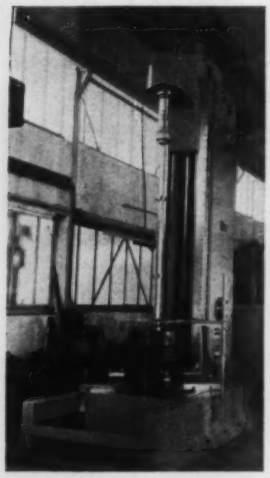
The spindle is driven by a 55-hp motor at speeds which are variable in steps between 10 and 100 rpm. The stroke is steplessly variable and is hydraulically actuated, with a separate motor, of 34 hp, to provide the power. Control is hydraulic, operated by push-buttons from a panel on the side of the column. There are also start and stop push-buttons on the workpiece carrier.



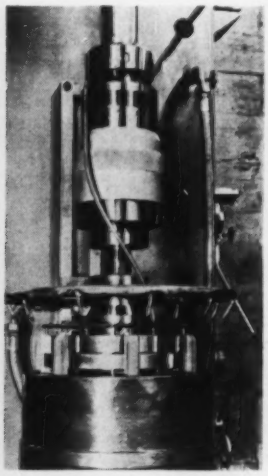
Method of clamping the workpiece and showing also the ring of nozzles to spray coolant round the revolving head of the honing machine

Ample clearance is allowed for handling work into and out of the machine, the height from the table of the workpiece carrier to the spindle nose in its uppermost position being 15 ft 1 in. The machine is highly adaptable in its range of work, as bores as small as 4 in. in diam can be honed; yet large cylinders, requiring 0.6 to 0.8 mm stock removal, can be completely honed in 90 to 100 min. The electrical equipment operates on alternating current at 380 volts and 50 cycles.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.



General view of model GR 4000 SW honing machine for diesel-engine cylinders



Honing head of machine at top of stroke, showing stones

### Pneumatic Comparator

THE Metrology Division of the National Physical Laboratory, England, has developed an apparatus for the rapid and precise measurement, by pneumatic gaging, of variations in diameter of bores. The range in diameter is from 2 in. to 6 in. (51 mm to 152 mm) and it is stated that the accuracy obtainable is within ±0.00001 in. (±0.25μ).

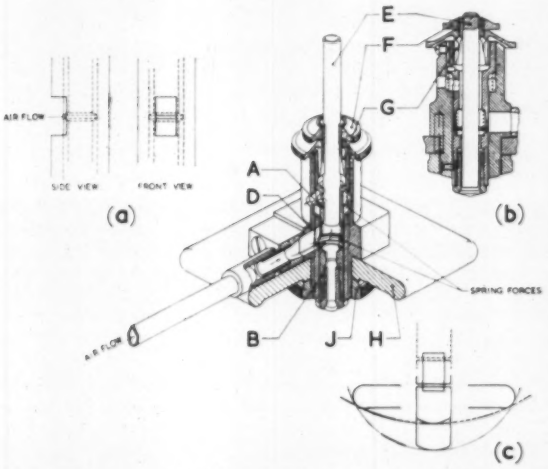
Referring to the diagrammatic section, the pneumatic comparator works as follows: Two tubular plungers, A and B, are free to move independently in a closely fitting bore in the body D. The plunger A is spring-loaded against the body, and B is spring-loaded against A.

Small pins in guides prevent the plungers rotating and stop them from falling out in handling. In the wall of the body D is cut a parallel-sided window, the inner extremities of which are masked by the plungers except for a small rectangular slot. The length of the slot is constant, being fixed by the width of the window, but the amount of opening depends on the separation of the two plungers. Air flowing into the body passes through the slot and thence escapes to atmosphere through vents in the walls of the plunger A and the body D.

The outer end of the plunger A is tapped to take a collet assembly carrying the rod E, at the end of which is a tungsten-carbide insert, radiused to form an anvil.

A similar insert forms the extremity of plunger B. These anvils contact the bore at opposite ends of a diameter, which thus controls the separation of the plungers and the area through which the air can escape. The knurled screws on the measuring head are for the initial rough adjustment and the final precise adjustment of the rod E within the bore. The head is located in the bore by the rectangular plate H, in which it is held firmly by the large knurled screw underneath the plate. The contact surface on the head is a shoulder which is machined accurately square with the common axis of the plungers.

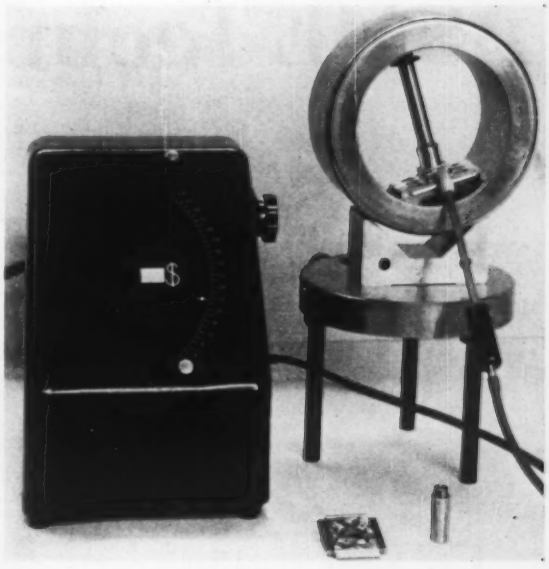
The plate has radiused edges and so forms a chordal




**Diagrammatic section showing how NPL pneumatic comparator works**

plane, parallel to the axis of the bore. As the axis of the plungers is perpendicular to this plane and bisects it transversely, it follows that the anvils on the ends of the plungers must lie in a diameter of the bore. The measuring head is manipulated within the bore by means of the air-inlet tube, which is provided with an ebonite handgrip for this purpose; and as the air-inlet tube may be of any length within reason, measurements may be made in the interior of a long bore.

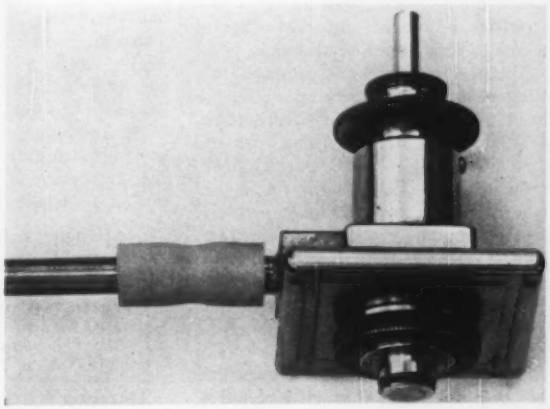
The indicating unit is a scale and pointer instrument made by the Sigma Instrument Company, Letchworth, England. Air at about 30 psig is supplied to a regulator within the instrument, from which it is delivered at a closely controlled pressure, $P$, of 5 psig to the first orifice in the measuring head. The actuating diaphragm cap-



**Complete assembly of NPL pneumatic comparator for measuring bores**

sule is exposed externally to this constant pressure and internally to the variable pressure, $p$, between the two orifices. The movement of the capsule is magnified mechanically to move the pointer over the scale. Full-scale deflection of the pointer represents a change in the pressure $p$ from 3.25 to 3.75 psig, corresponding to a change in the ratio $\frac{p}{P}$ from 0.65 to 0.75.

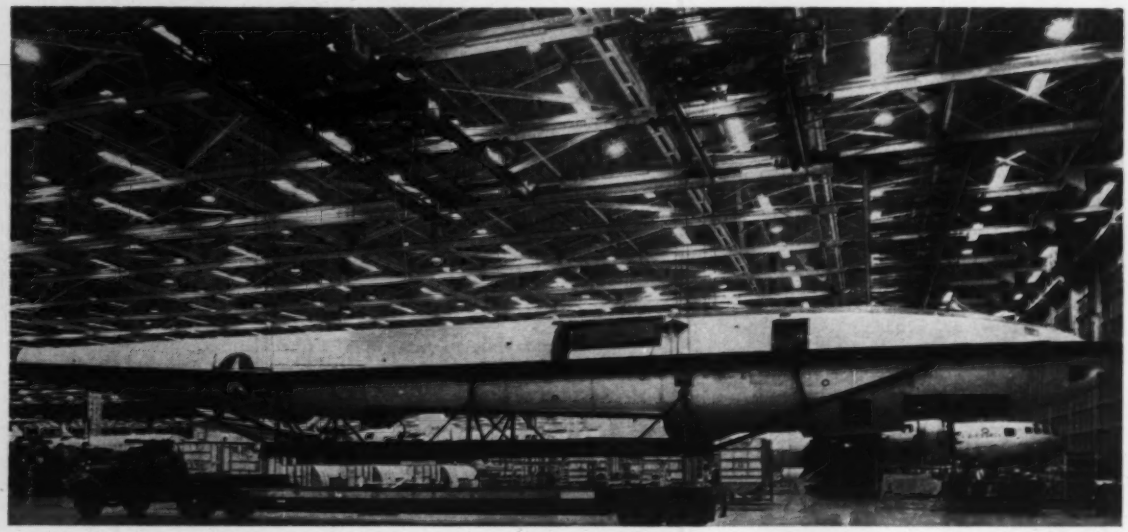
The instrument was calibrated by mounting the measuring head with the anvil B fixed in position and applying measured displacements to the anvil A. The sensitivity was adjusted so that unit division on the scale corresponded to an anvil displacement (= a change in diameter) of 0.000005 in. (0.125$\mu$). This represented an over-all magnification of about 20,000, with an effective range of 0.0003 in. (7.5$\mu$) at any given setting of the measuring head.



**Measuring head for NPL pneumatic comparator for bores**

# ASME Technical Digest

## Substance in Brief of Papers Presented at ASME Meetings



**Overhead cranes in Boeing Airplane Company's mother plant at Renton, Wash., loading B-47 fuselage section mockup**

## Materials Handling

**Modern Materials Handling as Employed by Boeing Airplane Company, Seattle Division,** by Bayne Lamb, Boeing Airplane Company, Seattle, Wash. 1956 ASME Spring Meeting paper No. 56—S-5 (multilithographed; available to Jan. 1, 1957).

THIS paper describes the organization of the materials-handling department, types of equipment used, cost and maintenance of equipment, scheduling of materials to be moved, and movement of materials along the assembly line.

The most predominant type of handling equipment used is the fork truck; Boeing has 180 of these, ranging in size from 1000 to 15,000 lb capacity. Along with the fork trucks, the in-plant material movement is accomplished with the use of many conveyers, industrial trucks, die handlers, mobile cranes, overhead cranes, towing tractors, shop lifters, hand jacks, etc.

The installation of two-way radios to aid in materials handling has been a profitable addition both monetarily and servicewise. By the use of radio, Boeing has been able, even through a period of growth, to maintain an expeditious service group with comparative small additions in either mechanical equipment or manpower.

Boeing's operation is a centrally operated unit with drivers dispatched to their various assignments by a dispatcher. In the past it was necessary for the driver to receive the job at the dispatch station on a dispatch slip. Therefore it was necessary for the driver either to return to the station after each assignment or to find the nearest telephone and call in. Through the addition of the radio units, Boeing has been able to eliminate 50 per cent of the deadheading or the nonpayload trips and has also effected savings in overhead cranes and highway-equipment operation by utilizing radio in the same manner. Savings in time, manpower, and equipment are similar.

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**Handling Timber With the Fork-Lift Truck and Materials Carrier,** by N. D. Thompson, Gerlinger Carrier Company, Dallas, Ore. 1956 ASME Spring Meeting paper No. 56—S-4 (multilithographed; available to Jan. 1, 1957.)

THIS paper describes the use of the fork-lift truck and materials carrier in the lumber industry in general, and specifically the handling of logs with the fork-lift truck. The problems encountered, some necessary design and operational features, and the limitations as well as the advantages of the type of equipment are explained. The conclusions shown in this paper describe how these units may be used successfully, and what the future may be for this type of operation. Recent applications of heavy-duty fork-lift trucks to log handling have shown them to have considerable economic advantages over the old methods. These trucks must have a capacity of at least 16,000 to 20,000 lb, and must be designed with at least 45 per cent of the vehicle weight on the drive wheels and some strengthening of the boom.

A "log push-off" carriage consisting of two vertical arms pivoted at the top and actuated by hydraulic cylinders has been found advantageous in unloading. With it, logs can be cold-decked up to the maximum lift height of the truck. Also growing in favor is the straddle-type material carrier, used primarily for transporting and capable of average maximum speeds of about 25 mph.

The major economic advantage of the fork-lift truck is said to be reduction of manpower needed to handle logs. A secondary benefit, however, lies in the more efficient use of operating time of other equipment, particularly logging trucks and tractors.

Another departure from ordinary practice is elimination of the log pond in favor of so-called "dry-pond" operation, wherein all logs are either cold-decked or fed directly to the multiple conveyer chains leading to the saw. This results in greater safety, since it places the operator close to the load, but with adequate protection allows him to position the logs exactly in the desired location. Elimination of cables and hooks keeps workers off and away from logs.

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**The Carrier Method of Handling as Applied in the Steel Industry,** by Carl Knapp, Clark Equipment Company, Benton Harbor, Mich. 1956 ASME Spring Meeting paper No. **56—S-6** (multilithographed; available to Feb. 1, 1957).

THIS paper describes how the carrier method of handling can be utilized in the steel industry to provide more flexible and more economical handling of in-process material. Data obtained from various mills actually operating carriers are used to demonstrate the effectiveness and economy of carrier operations.

Basically, the carrier method of handling involves the use of a rubber-tired straddle truck which drives over and straddles the load of steel to be moved. The steel is moved and stored on low-cost wooden or steel members known as bolsters. These bolsters are made to handle all sizes and shapes of steel.

Introduction of the carrier method of handling in steel plants has produced savings enough to pay for the carrier in less than a year. As a result, applications in the steel industry have been on the increase ever since the first application. The average amount of steel is 64 tons per hour for a truck of 50,000-lb capacity, and the hourly operating cost is $6.10. These figures indicate an average cost of 9.53 cents per ton of steel handled, which compares with 15 cents per ton for railroad switching equipment.

Low-cost storage areas are also indicated as one of the advantages of straddle-truck handling systems, since they permit removal of materials from under craneways, where space is valued in some instances at $12 per sq ft, to areas worth, in some instances, only 10 cents per sq ft. Thus floor space can be used more effectively for production facilities.

Other important advantages of the carrier method of handling are as follows:

The problems of transportation, materials control, and scheduling are simplified; materials deliveries to the mills are made more quickly and they are made on time; confusion and congestion in and around the mills are decreased.

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**Outstanding Materials-Handling Practices in the Pulp and Paper Industry on the West Coast,** by F. D. Helversen, Crown Zellerbach Corporation, San Francisco, Calif. 1956 ASME Spring Meeting paper No. **56—S-1** (multilithographed; available to Jan. 1, 1957).

THIS paper consists of 19 actual cases which endeavor to show the most modern and useful materials-handling methods employed in the operations of five West Coast companies. No theoretical considerations are given. The actual practices illustrated are as follows: Logging operations, wood handling at mill, chip handling, pulp handling from machine to railroad car, shipboard handling of paper rolls, converting plant materials-handling systems, wholesale-warehouse materials-handling system, and some experiments with glue-locked unit loads.

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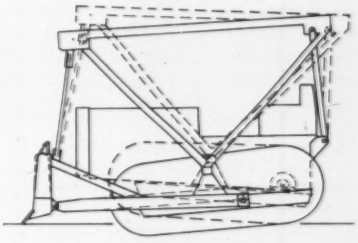
**The Design of Over-Hanging Attachments for Crawler Tractors,** by R. C. Shoemaker, Mem. ASME, Hyster Company, Portland, Ore. 1956 ASME Spring Meeting paper No. **56—S-2** (multilithographed; available to Jan. 1, 1957).

THE author studies the problems encountered when mounting overhanging equipment on standard crawler tractors, making due allowance for track oscillation, front spring action, and structural limitations of the tractor. Solutions to the problem are given by examples of successful tractor equipment.



**Unique cable-operated track-mounted bulldozer. Overhead frame allows track oscillation without affecting height of blade.**

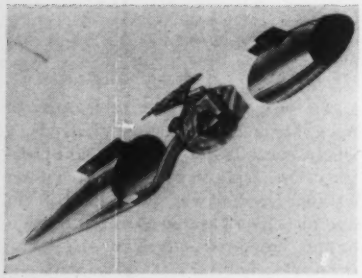
One such example is a cable-operated track-mounted bulldozer. This is a unique but successful solution to the problem of operating a cable-controlled dozer without loading the front end of the tractor body. Here an overhead frame is loosely supported at each crawler and at the rear of the tractor body, respectively. The frame projects over the front of the engine to suspend the dozer blade from a point that follows the average and is not dependent directly on the position of either crawler.

**Ross Series 100 rubber-tired straddle carrier moving a bulky crane girder. The girder is 92 ft long and weighs 22,000 lb.**

## Gas Turbine Power

**A Pod-Mounted Gas-Turbine-Driven Auxiliary Power Unit,** by R. Kress, Solar Aircraft Company, San Diego, Calif. 1956 ASME Spring Meeting paper No. 56—S-10 (multilithographed; available to Jan. 1, 1957).

THIS paper describes the requirements, design, and construction of an air-borne gas-turbine-driven auxiliary power unit installed in a streamlined pod. The unit was designed and developed by Solar Aircraft Company for use on the Convair C-131B airplane. The pod is designed to furnish either a-c or d-c electric power to the aircraft and can be used singly or in combination as aircraft requirements dictate. The units are completely independent of the aircraft engines or systems, except for fuel supply and electric power for starting. Normally two complete pod units are used per airplane, one mounted on the lower surface of the wing on each side of the fuselage. Each is attached by means of a standard bomb shackle. The pods are equipped with a complete fire-detection-and-extinguishing system, as well as provisions for anticing the air inlet.



**Exploded view of pod-mounted a-c auxiliary power unit**

The need for an auxiliary air-borne generator arises from the increased loads of present-day and proposed airliners, which carry more passengers, have greater range, and require a higher degree of passenger safety and comfort, such as food cooking and refrigerating facilities, lighting, pressurization, and air-conditioning equipment. Likewise, with the development of new navigational aids and communications equipment, military aircraft have been designed for all-weather operation, imposing greater loads on the electrical system. In addition, more extensive use of electronic search, fire-control, and guidance equipment has contributed to the increase in the electrical system loads.

Much of this electric power must be of a specialized type. Radio, radar, and navigation gear require large amounts of constant-frequency a-c power. With a few exceptions, provisions for a constant-speed takeoff have not been incorporated on main propulsion engines. The space required by a large generator often cannot be found in the limited envelope given the designer of the modern aircraft gas turbine. In addition, certain of the airplane's electric loads must be supplied when the ship is on the ground, at times when it is awkward and very inefficient to run up a main engine, and at an airfield where logistics problems have made the furnishing of ground-power units impractical. These requirements have combined to create a situation which is almost impossible to satisfy with generators mounted on the main engines, and are responsible for the ever-increasing use of auxiliary power units.

The advantages of the auxiliary generator described in the paper include low-weight-horsepower ratio, small size in relation to horsepower, ability to start and operate at low temperatures, ease of maintenance, ability to operate on a variety of fuels, high flywheel effect, and simple operating controls.

**Convair C-131B airplane, showing two gas-turbine-driven auxiliary-power-unit pods in place**

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**Portable 5000-Kw Railway and Skid-Mounted Gas-Turbine Power Plants,** by H. H. Rupp, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa., and W. N. Hornberger, Assoc. Mem. ASME, Westinghouse Electric Corporation, San Francisco, Calif. 1956 ASME Spring Meeting paper No. 56—S-7 (multilithographed; available to Jan. 1, 1957).

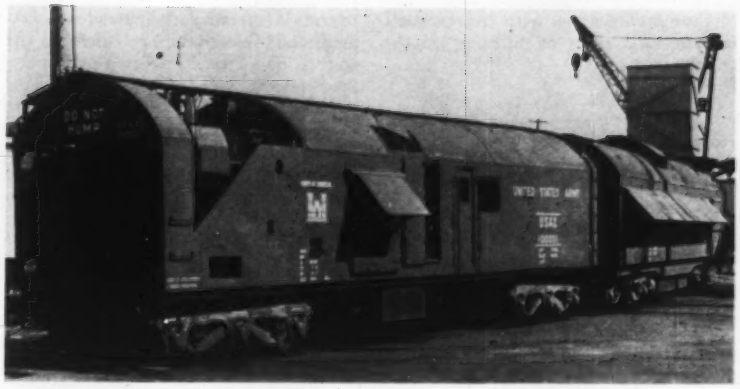
THE portable 5000-kw gas-turbine power plant, originally built for the U. S. Army, is one of the first mobile gas-turbine power-generating plants in this country and offers new flexibility in power generation and distribution. It is expected to find use in case of service interruption because of enemy attack, local disaster, flood, fire, drought in hydropower regions, or other conditions. Although distribution systems are interconnected to permit interchange of energy under adverse situations, local disaster conditions can disrupt service badly needed for rescue and reconstruction purposes, and a quick means of supplying this emergency power becomes of paramount importance.

The Army plant is mounted on two 54-ft-long railway cars. One car contains the gas-turbine-generator unit, all its auxiliaries, and the auxiliary control panel. Fuel-oil day tanks are located beneath this car. The second car provides space for the 6250-kv ampere outdoor-type transformer, 150 and 50-kw starting and auxiliary diesel-engine sets, switchboards, turbine remote-control panel, car-heating and air-conditioning equipment, storage battery, and axle-driven generator.

The gas turbine operates on the simple cycle of the combustion gas passing into the turbine with direct exhaust to the atmosphere. Incoming air is compressed to 6 atm for introduction into the combustion chamber. Full-load thermal efficiency is 18.5 per cent.

To facilitate maintenance, a continuous horizontal joint is provided in the combined compressor and turbine casing, with vertical joints between each component. Hence the covers may be lifted individually or as a unit without disturbing the rotating element. The stationary blading is in an assembly that easily can be removed from both the top and bottom sections of the casing without disturbing the rotor.

As to the flexibility of the Army plant, a crew of ten men can place it in service in 5 hours. This includes: (1) Starting up the auxiliary generator to get power for



**Transformer (control car) of portable 5000-kw railway gas-turbine power plant**

lights; (2) removing transportation blocking from turbine and generator; (3) removing roof sections and erecting exhaust stack; (4) making necessary plug-in connections between cars; (5) adjusting transformer to correct output voltage; (6) making electrical connections between railway car and electrical distribution system; and (7) connecting fuel lines to day-tank supply.

Maintenance costs have been established at approximately $1.50 per installed kw per year on a unit of this size and type. Availability records in excess of 8300 operating hours per year including a complete plant inspection of two weeks has proved it to be a dependable and reliable power plant.

This newest gas turbine is a mobile power plant with almost universal flexibility and yet commensurate with commercial power-plant design. There has been no attempt made to sacrifice life or dependability for a reduction in weight, yet maximum usage has been made of auxiliary equipment to keep the plant size to a minimum. The greatest asset in a plant of this type is that it provides a source of mobile power that is dependable and capable of long-time operation.

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**The Versatile Gas Turbine,** by H. R. Schelp, AiResearch Manufacturing Company, Phoenix, Arizona. 1956 ASME Spring Meeting paper No. 56—S-11 (multilithographed; available to Jan. 1, 1957).

Some of the characteristic properties of the gas turbine and its versatility are discussed. The gas turbine consists basically of four major components; namely, the compressor, the combustion chamber, the expansion turbine, and the accessories.

The expansion turbine provides the mechanical energy required by the compressor and the accessories in addition to free shaft power. The turbine can be arranged to drive an oversized compressor which can supply compressed air bled off in the form of pneumatic energy.

An important basic difference in the development of reciprocating engines and gas turbines is that higher powers can be achieved in reciprocating engines by adding cylinders. Higher power, at given inlet-flow Mach numbers, is achieved in gas turbines only by designing a larger machine. Therefore the development of a new gas turbine is more expensive. The author investigates the feasibility of designing the various components so that they can be combined to serve a multitude of applications and thus justify the larger expenditure.

The compressor, combustion chamber, expansion turbine, and accessories can be common among gas-turbine units accomplishing a variety of tasks. The author discusses the more elementary combinations of these common components: gas-turbine power unit, rigid; gas-turbine power unit, floating; gas-turbine compressor; gas-turbine compressor and power unit; gas-turbine universal. He shows that the large expenditure required for the development of a new gas turbine is justified by its simplicity, allowing many different designs.

The author concludes that the proper application of controls and safety features results in highly versatile, lightweight, and dependable engines, and he suggests that a single-stage compressor with a pressure ratio greater than 6:1 combined with a single-stage turbine and a variable-area nozzle may represent the next major step in the development of auxiliary gas-turbine engines. It is also fairly certain that in the future considerably higher gas temperatures will be used to provide lighter and more efficient engines.

## Metal Processing

**High-Flying Ti,** by S. R. Carpenter, General Dynamics Corporation, San Diego, Calif. 1956 ASME Spring Meeting paper No. 56—S-13 (multilithographed; available to Jan. 1, 1957).

Merits of titanium alloys are evaluated in relation to other materials for supersonic aircraft. Considerations are outlined for the use of heat-treated titanium alloys in design and production. Design and shop processing for stretch wrap forming at room temperature is reviewed, and hot forming is discussed.

From the standpoint of aerodynamic heating occurring at high Mach numbers, titanium appears to be one of the most useful metals for aircraft construction because it has a high strength-weight ratio at temperatures up to 600–800 F, depending on the alloy.

Comparing the benefits of titanium with aluminum and steel, the author discusses its strength-weight properties, heat-treat considerations, fatigue characteristics, and shop-forming methods with reference to aircraft. He asserts that since production of airplanes with speeds in excess of 1600 mph and boundary-layer temperatures above 350 F is rapidly approaching, aluminum alloys can no longer be used efficiently. Furthermore, the high-strength steels must be used with caution above 400 F because their drawing temperature is about 450 F.

## Wood Technology

**Glued-Laminated Timber Construction,** by V. Ketchum, Timber Structures, Inc., Portland, Ore. 1956 ASME Spring Meeting paper No. 56—S-15 (multilithographed; available to Jan. 1, 1957).

This paper discusses the history of standards development in the glued-laminated structural-timber construction industry, determination of wood stresses, modification of stresses, construction design, stitch bolts, thickness of laminations, nailed arches and frames, high-frequency gluing, lumber, appearance grades, scarfs, adhesives, manufacturing steps, laminating equipment, technical control, inspection, protection of structural members, nail-pressure gluing, field-type gluing, wood-pressure treatments, effects of cold temperatures, durability of glue lines, effects of vibration, checking of glued timbers, fire resistance, and problems of the laminator.

The author enumerates the advantages

of glued timbers as follows: Glued timbers can be built to any shape or design, straight, curving, or tapering. They are smaller strength for strength or stronger size for size than sawn timbers. They can be built to any size or length that can be handled and transported. All American structural woods glue easily and well so that glue lines are as strong and as durable as the wood. Large timbers can be seasoned throughout and do not have the checks and splits that are the trade-mark of large old-time wooden timbers. Small sizes and short lengths can be welded together and at last a timber stretcher has been invented. Pieces of wood can be so combined that the whole is stronger than the summation of its parts.

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**Lateral Tests on Full-Scale Lumber and Plywood-Sheathed Roof Diaphragms,** by J. W. Johnson, Oregon Forest Products Laboratory, Corvallis, Ore. 1956 ASME Spring Meeting paper No. 56—S-16 (multilithographed; available to Jan. 1, 1957).

THE results of testing 20 full-scale wood roof diaphragms in lateral loading to determine the influence of construction variables on resistance to static loads, simulating wind, earthquake, and blast forces, are discussed. The tests results indicate that differences in assembly of diaphragms can cause great variation in strength and stiffness.

Used in the tests were full-scale wood roof diaphragms measuring 60 × 20 ft. The diaphragms were tested in a steel-and-timber truss arranged to allow horizontal movement only. Loads were applied by hydraulic jacks.

Highest strength and stiffness were obtained with diagonally lumber-sheathed specimens having stiffened flanges. All framing and sheathing lumber was Douglas fir surfaced on four sides. Joists were 2 × 10 in. and sheathing was 1 × 6 in. Plywood-sheathed diaphragms with blocking were found to be stronger than lumber-sheathed diaphragms without stiffened flanges, and plywood-sheathed diaphragms without blocking resisted deflection about as well as diagonally lumber-sheathed diaphragms without stiffened flanges. The plywood was Douglas fir interior unsanded C-D sheathing grade, including 3-ply $^3/_8$-in. and 5-ply $^1/_2$-in. thicknesses.

Longitudinally lumber-sheathed diaphragms had comparatively low and inadequate resistance to test loading.

A number of other variables were compared, including dry versus green lumber, nailing, use of corrugated metal fasteners, variations in reinforcement, use of a herringbone pattern of sheathing, effect of skylight openings with conventional framing, and effect of different length-width ratios.

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**How RF Concerns the Wood Industry,** by J. W. Mann, Mann-Russell Electronics, Tacoma, Wash. 1956 ASME Spring Meeting paper No. 56—S-17 (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

HIGH-frequency alternating currents to the order of several millions of cycles per second applied to dielectric materials are referred to as "RF heating," and are used widely in wood lamination as a means of setting synthetic adhesives in such members. Aspects of Federal rules and regulations and the needs of industry are set forth. Means of accomplishing industrial applications; methods of estimating time cycles; and the unique properties of the high-frequency field of force such as selectivity to conductive paths and nonuniformity of the heat placement in dielectrics are covered in some detail with specific examples.

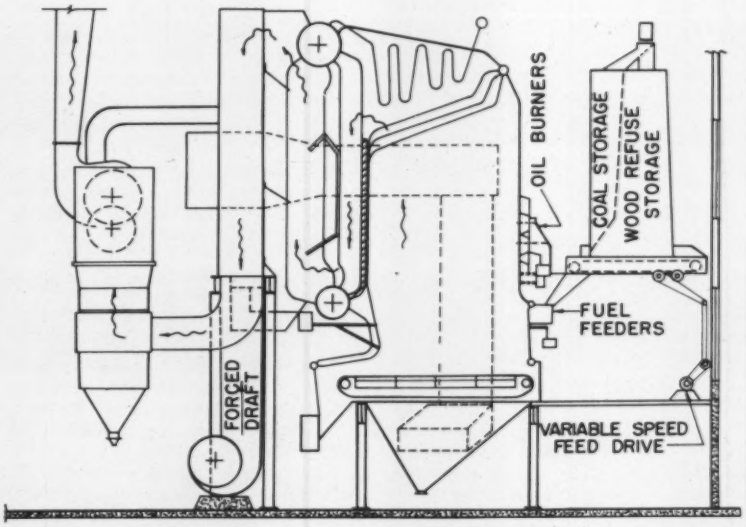
## Fuels Technology

**Wood-Refuse Spreader-Stoker Firing of Two Steam Generators,** by R. W. Martin, Jr., Eugene Water & Electric Board, Eugene, Ore. 1956 ASME Spring Meeting paper No. 56—S-21 (multilithographed; available to Jan. 1, 1957).

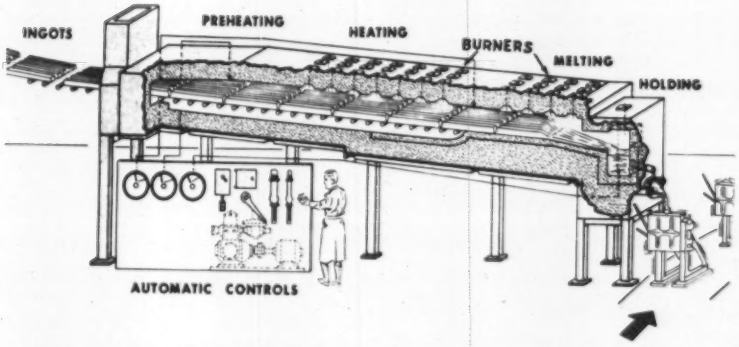
THIS paper covers some of the design, operation, and maintenance experience obtained during the installation and operation of one large spreader-stoker-fired wood-refuse-burning boiler and the conversion of one smaller Dutch-oven-fired boiler to spreader-stoker firing. This experience extends over a period of five years and 60,000 hr of boiler operation.

The conversion of the Dutch-oven boiler resulted in faster response to load changes, more applicable to combustion control, better availability for service, and excellent adaptability to multiple fuels. Installed in 1950, the unit was equipped for multiple fuel firing—oil, coal, or wood refuse. The solid fuels are burned on a traveling grate having mechanical spreader-stoker feed.

The wood-refuse fuel is fed to the bin storage from an incoming 30-in-wide belt conveyer onto a belt shuttle conveyer which distributes the fuel across the full 30-ft width of the storage bin. This bin is sectionalized to provide separate storage for both wood waste and coal. Capacity of the bin is 30 units (200 cu ft per unit) of wood refuse and 20 tons of coal. The drag chains shown in the bottom of the bin are of the H-112 type. One set of two chains supplies each of eight fuel feeders by dragging fuel from under the storage bin in a direction away from the furnace, the fuel dropping through the chain links and traveling with the bottom links toward the furnace where they again drop through the links down the fuel shoots to the mechanical spreader stokers of the standard coal-feeder type altered to accommodate the greater volume necessary for handling wood refuse.




**Spreader-stoker-fired steam generator. 175,000 lb per hr—wood fired. 240,000 lb per hr—oil or coal-fired.**




**Use of torchless gas burners for continuous high-speed melting of aluminum ingot**

**Processes and Product Improvements to Be Anticipated With Natural Gas,** by R. C. LeMay, Mem. ASME, Seals Corp. of America, Dresher, Pa., 1956 ASME Spring Meeting paper No. **56—S-14** (multilithographed; available to Jan. 1, 1957).

THIS paper reviews a number of new or recently improved heat processes now employed in areas where natural gas is already in use, and which may be of interest to Pacific Northwest engineers with the arrival of natural gas in that area.

Applications discussed by the author in which natural gas offers advantages over other types of fuel include metallurgical uses, food baking and drying, brazing, glassworking, varnish cooking, and direct heating of flowing aqueous materials.

He points out that natural gas has many technological advantages over other fuels which are even more important than its low cost. Some of these are cleanliness, uniformity of heating, and flexibility of application—features that suit it for direct-fired applications as integral parts of automated production lines.

## Heat Transfer

**Selection of Optimum Configurations for a Heat Exchanger With One Dominating Film Resistance,** by Dr. E. R. G. Eckert, Mem. ASME, and T. F. Irvine, University of Minnesota, Minneapolis, Minn. 1956 ASME Spring Meeting paper No. **56—S-20** (multilithographed; available to Jan. 1, 1957).

THIS paper considers the problem of optimizing heat exchangers in which the heat resistance on one side is so small that it can be neglected. Such applications as occur in nuclear-reactor design have made this type of study particularly desirable. The paper compares different heat-exchanger geometries on the basis of pressure drop, frontal area, and space and weight requirements. It also discusses the possibility of improvement in the performance of a heat exchanger by arranging it at an angle with the oncoming coolant stream. The author shows that considerable savings in the power expended can be obtained by a proper choice of the exchanger geometry especially when the heat-exchanger weight is of primary importance.

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**Flow Through Annular Orifices,** by K. J. Bell, General Electric Company, Richland, Wash., and O. P. Bergelin, Mem. ASME, University of Delaware, Newark, Del. 1956 ASME Spring Meeting paper No. **56—S-22** (multilithographed; available to Jan. 1, 1957).

Coefficients for the annular orifice formed between a circular disk and a cylindrical tube are reported for several orifices having disk-diameter to tube-diameter ratios between 0.95 and 0.996, and orifice length-to-width ratios from 0.118 to 33.3. The orifice Reynolds number range is from 5.0 to 20,000 for both tangent and concentric orientations of the disk. Theoretical and semi-empirical equations are developed to predict coefficients for annular orifices.

## Power

**The First Commercial Steam Generator at Supercritical Pressure,** by J. D. Andrew, Mem. ASME, The Babcock & Wilcox Company, New York, N. Y. 1956 ASME Spring Meeting paper No. **56—S-12** (multilithographed; available to Jan. 1, 1957).

THIS paper is a discussion of the background and history, theory of operation, design, functional considerations, and fabrication of the first commercial supercritical-pressure boiler. The tests made explore the following: Properties of the fluid; pressure-drop characteristics with variations in mass flow, pressure, and temperature; response characteristics and the control required; heat-transfer rates of the fluid film; water-conditioning requirements; and internal conditions as affected by water conditions, heat fluxes, mass flows, pressures, temperatures, and flow arrangements.

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**Integration of Steam and Hydro Power in Northern California,** by Walter Dreyer, Pacific Gas and Electric Company, San Francisco, Calif. 1956 ASME Spring Meeting paper No. **56—S-8** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

THIS paper reviews the history of installations and integration of steam and hydro power in northern California. The functions of steam-generated power are outlined as the following: Effecting the best system economy, stand-by at important load centers, meeting the seasonal hydro deficiency; and meeting the dry-year hydro-energy deficiency. As far as possible, steam plants should be located at important load centers to carry out these functions. Being located at load centers, generating units can also be designed to assist in regulating incoming transmission lines, thereby reducing or perhaps eliminating the cost of synchronous condensers which otherwise would have to be provided at the termini of the lines from the hydro plants.

In an integrated system, co-ordination of storage-reservoir operations, some of which may be cyclic as well as seasonal, will allow the maximum amount of available hydro power to be utilized during periods of normal or of heavy runoff. A saving of fuel will result thereby because the steam plants are not required to generate as much energy. The author emphasizes the importance of making effective all of the installed or dependable capacity without duplicating installations. He concludes with a brief discussion of reserve capacity in a mingled power system.

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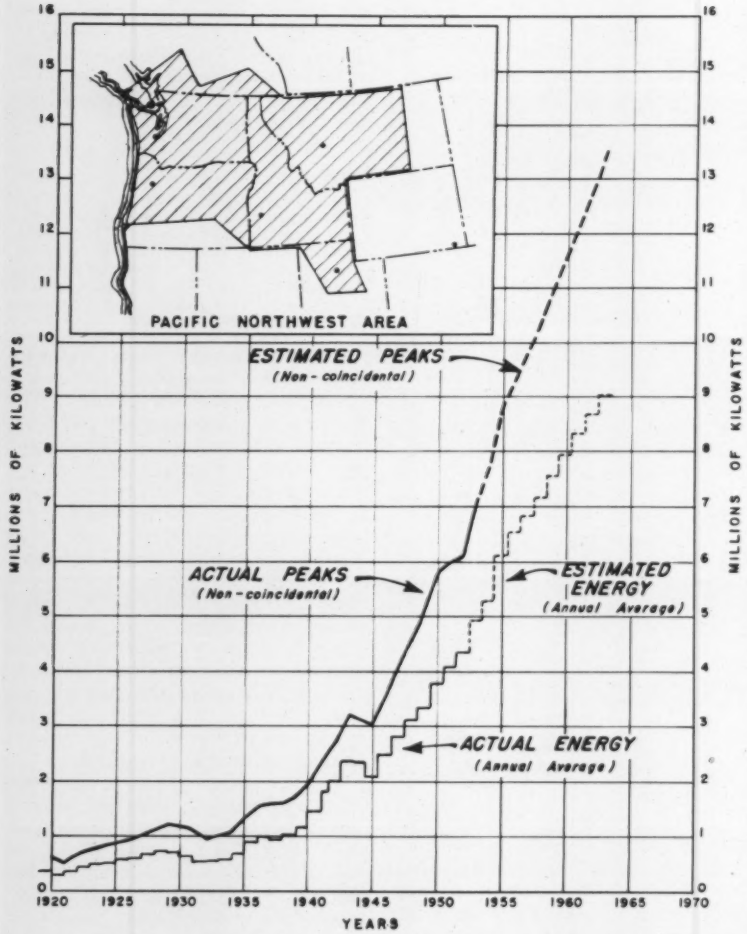
**Hydro Power in the Northwest,** by J. P. Buehler, Bechtel Corporation, San Francisco, Calif., and O. E. Walsh, Portland General Electric Company, Portland, Ore. 1956 ASME Spring Meeting paper No. **56—S-9** (multilithographed; available to Feb. 1, 1957).

A DISCUSSION is given of the hydro-power situation in the Pacific Northwest area, including pertinent information on the electric utility-load growth, both actual and estimated future, and the required additional capacity to meet the estimated firm peak loads by 1963–1964. The potential hydro-power developments




**Pacific Northwest area electric-utility loads. Actual: 1920 to 1953, inclusive. Estimated: 1954 to 1964 inclusive.**

under consideration for construction and the existing difficulties hampering many of these projects are examined. Current studies under way to develop the position and timing thereof of combining thermal power with the Northwest hydro system are discussed.

The study of load growth within the area began in 1920, when the actual peak load was 700,000 kw. In the 20-year period up to 1940, the peak increased to 2 million kw, a total less than three times the original figure, whereas the growth in the 14-year period between 1940 and 1954 represents a growth of three and one-half times. This growth in the latter period is considered by the authors as the outstanding industrial development in the Pacific Northwest during that time.

Over the period since 1920 the yearly average load increased 7.60 per cent; the latest five-year period, however, has shown a yearly average increase of 9.34 per cent. Based on these computations, the estimated annual increase for the next eight years will be 6.62 per cent.

It is on this basis of estimated load growth that the authors examine the ability of dependable capacity from existing, under construction, and definitely scheduled power resources to meet the estimated peak loads up to 1964. Specific examples are discussed and the physical, practical, or ideological difficulties of each are explained as they affect the completion and placing into service of sufficient capacity to alleviate the Pacific Northwest's projected growing pains.

The area discussed includes all of Washington and Idaho, and parts of Utah, Montana, Oregon, and British Columbia.

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**An Economic Appraisal of Nuclear Versus Hydro-Power Development in the Pacific Northwest,** by K. M. McCaffree, University of Washington, Seattle, Wash. 1956 Spring Meeting paper No. 56—S-19 (multilithographed; available to Jan. 1, 1957).

THIS is a comparative survey of power costs for nuclear and hydro projects to determine when, if not now, nuclear power will become competitive with or replace hydro facilities as the primary source of electric energy in the Pacific Northwest. Problems in estimating present and future cost data for both sources of electricity are outlined, and some bases for judging the relative economic feasibility of nuclear power plants versus hydroelectric projects are suggested.

With numerous limitations and possible uncertainties pointed out, the author concludes that hydro development will probably continue for several years, but after 1970, at least, a significant part of base-system needs in the Pacific Northwest will very likely be met by nuclear power sources. However, although capital investment costs still favor hydroelectric development, the picture may change after actual costs of nuclear plants are available for study, making it wise for utilities to delay expansion until more information is obtained.

## Management

**Practical Equipment-Replacement Economics,** by P. A. Scheuble, Jr., A. O. Smith Corporation, Milwaukee, Wis. 1956 ASME Engineering Conference paper No. 56—MGT-2 (multilithographed; available to Jan. 1, 1957).

THIS paper discusses various principles on which the economic replacement of equipment must be based.

To make equipment replacement pay off we must have a coherent plan, if we are to get the most for our investment. Such a plan should include the following:

1 An objective study of proposals supported by records or reasonable estimates. Such an analysis also includes a periodic check of equipment condition and operating costs which may signal deterioration. Good working records are required, but they need not be expensive since they usually can serve multiple purposes.

2 An economic analysis that will tie together the engineering, cost, and financial factors involved. A priority and

timing of replacements should be established.

3 A two-way communication among, and between, all levels in the organization, so that plans can be correlated with future company planning and capital availability.

4 A broad management viewpoint in regard to the use of funds for replacement purposes, the setting up of adequate reserves for replacement, and an appreciation of its competitive position in regard to the efficiency of its plant.

5 An after-the-fact review of proposals installed.

6 A program that will provide proper equipment maintenance, and constant supervisory effort to instruct and prevent mishandling of equipment.

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**The Art of Applying Science,** by L. E. Lattin, Southwestern Bell Telephone Company, St. Louis, Mo. 1956 ASME Engineering Management Conference paper No. **56—MGT-3** (multilithographed; available to Jan. 1, 1957).

This paper is concerned with the skill of people in putting fact, laws, and proximate causes, proved by people, to the practical use of people. Obviously this skill, this functioning of the engineer, is of people, by people, and for people. The fullest achievement, therefore, requires understanding and use of the "human equation" quite as much as the mathematical equation.

## Instruments and Regulators

**Spectral Response of Control System Containing Zero-Memory Nonlinearity to Random Inputs** by Y. Sawaragi, Mem. ASME, Kyoto University, Kyoto, Japan, and S. Takahashi, Mem. ASME, Kyoto Technical College, Kyoto, Japan. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-15** (multilithographed; available to Jan. 1, 1957).

In this paper, an approximation technique of analyzing spectral response of the so-called "type-O" nonlinear control system to random inputs operating in the regions displaced from the nominal zero value is explained. The analysis is originally based on the quasi-linearization method extended by R. C. Booton. The response of nonlinear element to random input is analyzed by the use of Rice's characteristic function technique, and from the results the equivalent gain of zero-memory nonlinear element for random input is reduced.

The forms of the zero-memory nonlinear characteristics considered here are neutral zone, saturation, and on-off relay. Two typical nonlinear control systems are analyzed as a specific application. Throughout this paper, it is assumed that the system inputs (inputs composed of "orders" and "disturbances") are random, with Gaussian distribution of amplitudes.

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**Nonlinear Phenomena,** by C. A. Ludeke. University of Cincinnati, Cincinnati, Ohio. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-7** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

This paper presents briefly some phenomena associated with nonlinear systems. The phenomena discussed are wave form, frequency dependence on amplitude, the jump phenomenon, subharmonic oscillations, limit cycles, and frequency entrainment. Experimental examples of such phenomena are given.

The paper does not attempt to solve the problems presented, but suggests them as phenomena compelling pure and applied research to arrive at solutions for physical phenomena requiring nonlinear differential equations which are in better agreement with reality and which avoid the idealization of having been linearized.

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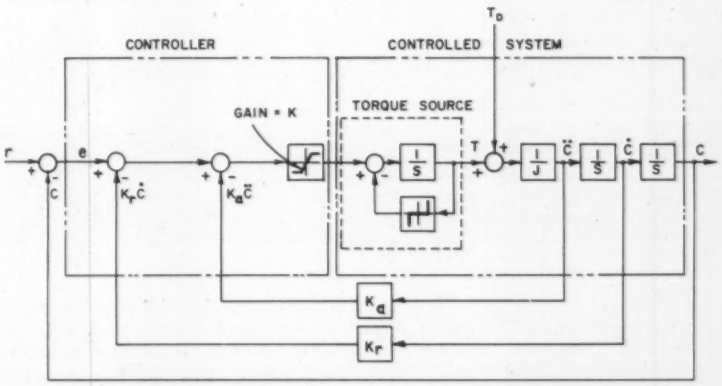
**Design and Analog-Computer Analysis of an Optimum Third-Order Nonlinear Servomechanism** by H. G. Doll and T. M. Stout, Schlumberger Instrument Company, Ridgefield, Conn. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-10** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).




**Block diagram of the third-order system with a linear or relay controller**

After a brief review of the theory underlying a second-order programmed control system, this paper describes the calculation of the switching relation for a particular third-order system and a laboratory realization, using an electro-optical two-variable function generator, for use in an analog-computer investigation. Results of computer tests with a variety of inputs are given for this system as well as competitive linear and relay modes of control.

The design objective which distinguishes deliberately nonlinear control systems is minimization of the response time for step inputs by proper automatic timing of relay operations. For a second-order relay servomechanism, the required switching relation is expressed by a curve in a two-dimensional phase plane which can be realized by a one-variable function generator in combination with linear elements. For a third-order system, the switching relation is expressed by a surface in a three-dimensional-phase space and requires a two-variable-function generator for its realization.

The switching surface is computed in this paper for an idealized third-order positioning servomechanism having an output member characterized completely by its moment of inertia and a torque which varies linearly with time between two limits; small-signal nonlinearities such as backlash or relay threshold are neglected. An electro-optical two-variable-function generator is employed in an analog-computer study of this system.

For purpose of comparison, two alternative modes of control are also examined. The system using programmed control shows the expected superiority for step inputs, the advantage being greatest for small step magnitudes. For sinusoidal or random inputs, programmed control is superior when the input amplitude and/or frequency are low but exhibits some anomalous behavior for large amplitudes and/or frequencies, which result in inferior performance. Parameter

tolerances for programmed control systems are somewhat less severe than anticipated.

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**On the Analysis of Linear and Nonlinear Systems,** by Marvin Shinbrot, National Advisory Committee for Aeronautics, Moffett Field, Calif. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-2** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

A GENERAL theory of a certain class of commonly used methods for the analysis of linear systems from measured response data is described. It is shown that, when viewed from this general point of vantage, all of these linear techniques can be extended in a natural way to apply to nonlinear systems. In addition, through use of the general theory, a new method, possessing certain advantages over those used previously, is derived. Finally, the effectiveness of the new method is illustrated by several examples.

One new method is described in some detail. In certain cases, it reduces to the well-known Fourier transform method but in all cases has certain advantages over this latter method and over methods heretofore used. Its superiority is based on two facts: (*a*) There is the heavy dependence on the initial conditions which occurs when using most of the previously known equations-of-motion methods; this dependence is entirely eliminated in the new method. (*b*) The fact that most of the methods used to this time demand an infinitely long record for their rigorous application; this demand is not made by the new method. Finally, it is also mentioned that the time of application of the method is no greater than that for existing methods and that the method is well suited to machine computation.

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**Physical and Mathematical Mechanisms of Instability in Nonlinear Automatic Control Systems,** by R. E. Kalman, Columbia University, New York, N. Y. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-16** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

THIS paper is a critical examination of the stability problem in automatic control systems containing nonlinear elements. An attempt is made to classify and isolate essentially different phenomena and to illustrate each type by means of simplified but representative examples. Particular attention is paid to the effects of system parameters and system inputs in provoking or destroying instability.

The phenomena discussed are so diverse that no over-all conclusions are made; however, the classification adopted here should be of help in recognizing important and unimportant aspects of problems in nonlinear control-system design.

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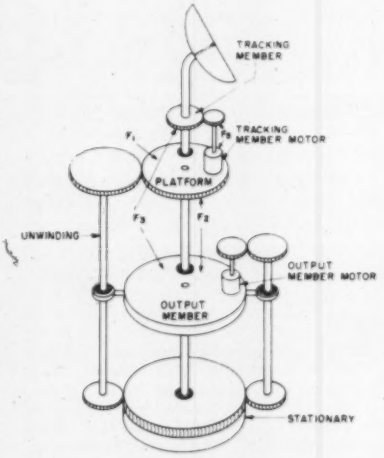
**Effects of Nonlinearities in Multiloop Lead-Angle-Prediction Systems,** by A. A. Clark and H. J. Pixley, General Electric Company, Schenectady, N. Y. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-18** (multilithographed; available to Jan. 1, 1957).

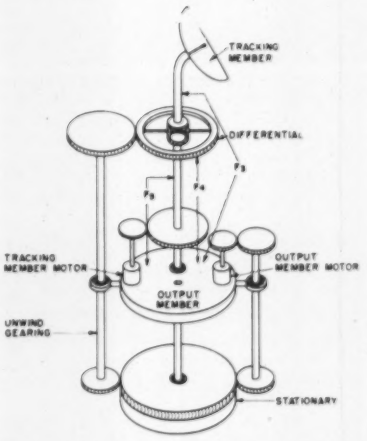
THIS paper deals with the effects of certain nonlinearities in a laboratory model of a multiloop prediction system. The results obtained and discussed are experimental rather than analytical. The laboratory model used in this work simulates a multiloop prediction system in which the tracking member is located physically on the output member. The motion of the output member is subtracted mechanically from the motion of the tracking member.

The imperfection in subtraction caused by backlash and the interaction in the system caused by coulomb friction between members are discussed. The prediction operation is shown to accentuate greatly the backlash and friction effects. Test data showing the effects of these imperfections on system performance are given and discussed for two physical configurations.

The two forms of mechanically unwound systems discussed in this paper are (1) "platform unwinding" wherein the entire tracking member servo equipment is located on a platform which is caused to remain angularly fixed in space as the output member moves, and (2) "differential unwinding" wherein only the tracker head is held fixed in space as the output member moves. Unwinding through a differential causes torque disturbances on the tracking member servomotor. As far as servo stability and roughness are concerned, this torque disturbance is the only appreciable difference between differential unwinding and platform unwinding. Although this indicates a preference for platform unwinding, the author considered it important also to study differential unwinding, since mechanically it is more readily achieved.




**Sketch of platform unwound system**




**Sketch of differentially unwound system**

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**Optimum Nonlinear Control,** by R. Oldenburger, Mem. ASME, Woodward Governor Company, Rockford, Ill. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-13** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

THIS paper is concerned with the response of a controlled system after an initiating disturbance has died out. Such a transient is obtained, for example, when the load on a prime mover is suddenly rejected or the speed setting of an engine governor is instantly switched to a new value. It is assumed that the rate of change of the controlling variable with respect to time is bounded, and that the maximum rate of change can be obtained arbitrarily. Thus the speed of a hydraulic governor servo is limited. The best return to equilibrium (minimum over or underswing, minimum duration of the transient, etc.) can be obtained under rather general conditions by having

the servo or its equivalent travel only at maximum or zero speed. Control functions exist which give the optimum transients. These functions are nonlinear.

The results of theoretical studies to enable the control designer to obtain optimum or nearly optimum transients are given here along with practical compromises. All results have been verified in the laboratory with physical devices (governors) of various kinds and automatically controlled systems.

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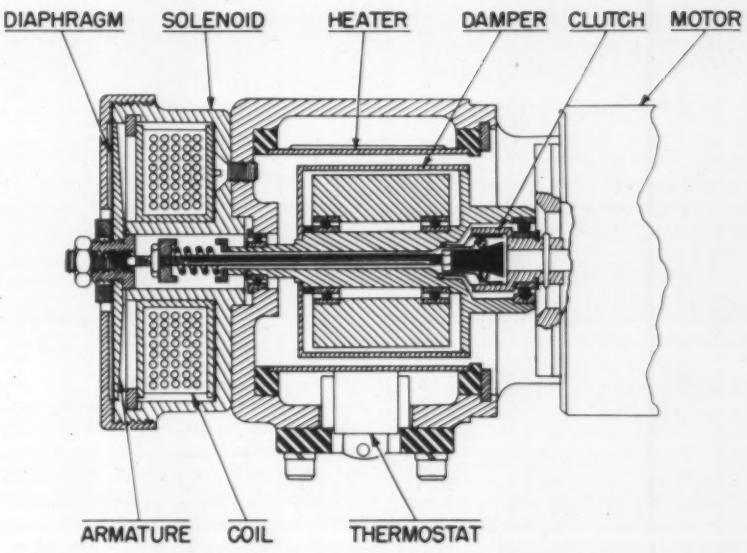
**Electrohydraulic Servomechanism With an Ultrahigh Frequency Response,** by D. P. Eckman, Case Institute of Technology, Cleveland, Ohio, and C. K. Taft, Assoc. Mem. ASME, and R. H. Schuman, Warner and Swasey Company, Cleveland, Ohio. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-8** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

THIS paper presents an analysis of a positional servomechanism of very high performance. This control employs an electric error transducer which actuates a pilot valve by means of an amplifier and a torque motor to position a hydraulic cylinder. The control was to have a frequency response whose amplitude ratio was nearly 1 to 200 cps at an amplitude of 0.001 in. with 100-lb dry friction and a load mass of 200 lb. These specifications were exceeded by the control described herein. The optimum open-loop gain and the closed-loop frequency response are determined by linearizing the system equations and using Laplace transform methods.

The system also was analyzed by solving the nonlinear equations on an electronic analog computer to determine optimum gain, transient response, and frequency response. A comparison of the results indicates that for input signals which cause the control to operate outside the region in which the linearizing assumptions apply, the linear analysis still gives results which agree with those of the nonlinear analysis within a factor of three.




**Cross-sectional view of the dual-mode damper package attached to a servomotor**

**A Dual-Mode Damper-Stabilized Servo,** by J. Jursik, Clevite Research Center, Cleveland, Ohio, and J. F. Kaiser and J. E. Ward, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-6** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

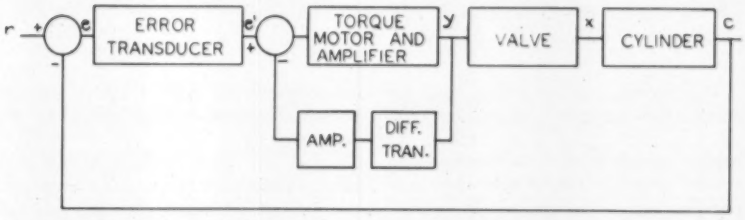
THE highly oscillatory response of an inertia-damper stabilized servo to large step inputs can be improved greatly by changing, for large error, the coupling torque between the damper and the drive motor. This coupling can be either a simple slip clutch, or an electrically operated clutch controlled by a function of the servo error. The error-actuated clutch, although more complicated, has been found to be superior because of greater reliability.

This paper presents the results obtained from an experimental model and an analog-computer study of the dual-mode damper-stabilized servo. For large step inputs, this dual-mode method of operation resulted in a reduction of settling time by a factor of 5.8 and reduction of peak overshoot by a factor of 200 as compared with single-mode operation.

The damper consists of a sintered-tungsten slug mounted on bearings within a spun aluminum case filled with a silicone damping fluid. The aluminum damper case is supported by two bearings, one fixed in an extension of the motor housing and one running on the motor shaft. The clutch is composed of a small collet attached to the damper case, which can be expanded into a drum attached to the motor shaft.

The clutch normally is kept engaged by a spring which acts on a push rod so as to expand the collet. The means for controlling this clutch is provided by the solenoid, which releases the collet by acting on the push rod in opposition to the spring. A 4-lb force is required to release the clutch and the necessary travel is 0.005 in. The return spring for the armature is provided by the thin diaphragm attached to the armature at its center. The clutch can be disengaged by approximately 2.5 watts in the solenoid coil. The operating time for the clutch is less than 10 millisec. Adjustments are provided for setting the maximum slip torque of the clutch.

Because the damper is sensitive to fluid viscosity, a thermostatically controlled heater tube is included in the assembly to keep the temperature of the fluid in the damping gap at 160 F. The heater is required for air-borne use, but may be dispensed with for other applications. The entire assembly is $2^3/_8$ in. long × 2 in. in diam and has been designed to operate with a Mark 8, 400-cps servomotor.




**Block diagram of an electrohydraulic servomechanism with an ultrahigh frequency response**

**Hunting Due to Lost Motion,** by H. Poritsky, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-12** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

HUNTING of a servosystem due to lost motion, in one of its mechanical links, for example, but in absence of input signals, is considered. If the slack is assumed to be taken up suddenly, the motion is governed by a linear differential equation, but with proper discontinuities when the direction of motion in the loose link is reversed.

For the case of second-order systems it is shown that if the characteristic roots are complex, a period hunting motion always exists, and that the system, no matter how it is started, will converge to a stable position at either end of the lost-motion band. Third and higher-order systems are studied in a similar way and the equations for determination of periodic hunting motion obtained. For second-order systems in which the system "coasts" as the slack is taken up, it is shown that the periodic hunting motion is eliminated when the characteristic roots are real, but it still persists when the roots are complex.

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**Determination of the Characteristics of Multi-Input and Nonlinear Systems from Normal Operating Records,** by T. P. Goodman, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-17** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

A METHOD is presented for discovering, from the random variations in normal operating records, the impulse responses, or weighting functions, relating an output of a system to two or more inputs that are mutually correlated. This method makes use of the statistical autocorrelation and cross-correlation functions of the system inputs and outputs. From these correlation functions, the weighting functions are obtained by a process of deconvolution by means of an electronic delay-line synthesizer. The method is described first for linear systems and is then applied to nonlinear systems. It is an extension of a method presented in an earlier paper for discovering the weighting function of a linear system with one input.

The method presented here should facilitate the determination of weighting functions of systems with multiple, mutually correlated inputs from normal operating records. For a nonlinear system, the optimum linear representation given by this method supplies useful information for control purposes, and may be used as a first step toward a more refined description of the system.

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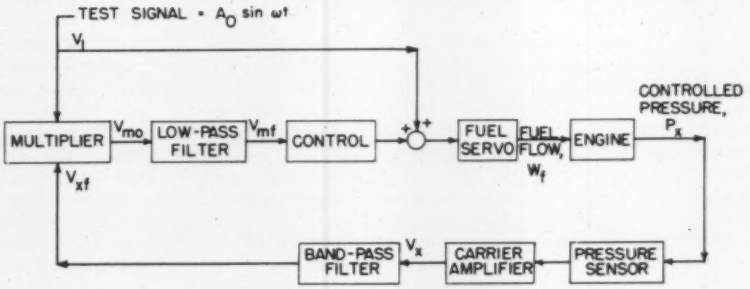
**Experiments With Optimalizing Controls Applied to Rapid Control of Engine Pressures With High-Amplitude Noise Signals,** by G. Vasu, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-14** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

THIS paper presents a discussion of an optimalizing control which varies the input fuel flow to a flight propulsion system in such a manner as to produce automatically the maximum output pressure. Experimental data are presented illustrating the control behavior for a range of flight conditions, for various control settings such as gain and integral time constant, for various amounts of filtering, etc.

The paper includes, first, a description of the type of optimalizer control used, with a discussion of its principle of operation, including the effect of component dynamics and noise on control operation. Next, the basic behavior of the system as determined experimentally is discussed; and finally, the effect on performance of filtering, test-signal amplitude, etc., is discussed.




**Block diagram of optimalizer control showing output of control added to test signal**

The experimental data indicate that the continuous test-signal optimalizer control applied to the control of compressor-output pressure in a flight-propulsion system gave very nearly maximum output pressure over a range of flight conditions. The type of response varied greatly over the range of Mach numbers due to the variation in the shape of the engine static characteristics from one Mach number to another. The data indicate that good filtering was not required; the system could therefore be made to operate faster by removing part or all of the filtering. The minimum test-signal amplitude was found to be dictated not by the signal-to-noise ratio, but by imperfections or minor peaks in the engine static characteristics. For very small test-signal amplitudes, the control would hang up on a minor peak.

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**A Resume of the Development and Literature of Nonlinear Control-System Theory,** by T. J. Higgins, University of Wisconsin, Madison, Wis. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-4** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

THE first section of this paper stresses the fact that nonlinear control-system theory is rooted in the theory developed earlier for the solution of other types of nonlinear systems, especially those of nonlinear mechanics and nonlinear electric circuits; whence the control engineer interested in nonlinear systems should gain a thorough knowledge of nonlinear-system theory in the large.

To facilitate such study this paper advances a concise resume of the major stages of development of nonlinear-system theory to date; a list of papers which encompasses a more detailed account of development; a list of the principal books on general theory; and a list of sources on special aspects of the general theory—each item being characterized as to its particular merit. The principal methods of nonlinear analysis and the phenomena of particular interest in nonlinear systems are noted. Finally, the

possible use of these methods and the actual occurrence of these phenomena in nonlinear control-system analysis are emphasized.

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**Basic Methods for Nonlinear Control-System Analysis,** by T. M. Stout, Schlumberger Instrument Company, Ridgefield, Conn. 1956 ASME Instruments and Regulators Division Conference paper No. 56—IRD-9 (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

AFTER a review of the reasons for control-system analysis and the difficulties encountered in analysis of nonlinear systems, the important phase-plane and describing-function methods are explained with the help of several simple examples. It is shown that the phase-plane method is best adapted to transient analysis of second-order systems and that the describing-function method is intended primarily for stability analysis of higher-order systems. Details and extensions of both methods are discussed in two appendixes, and a number of less important methods are mentioned.

## for June, 1956

THE June, 1956, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

### Technical Papers

Pretwisted Beams and Columns, by John Zickel. (55—A-28)

Multiple-Branch Piping-Flexibility Problems, by J. W. Soule. (55—A-83)

Tensor-Flexibility Analysis of Pipe-Supporting Systems, by J. W. Soule. (55—A-82)

Cantilever Beams of Cylindrically Aeolotropic Material, by W. S. Ericksen. (55—A-41)

On the Torsion of Rectangular Sandwich Plates, by Paul Seide. (55—A-40)

Bending of Thick Circular Plates on an Elastic Foundation, by Daniel Frederick. (55—A-36)

Effect on an Acoustic Medium on the Dynamic Buckling of Plates, by F. L. DiMaggio. (55—A-35)

Buckling of Simply Supported Plates Tapered in Planform, by Bertram Klein. (55—A-39)

Creep Stresses and Deflections of Columns, by by T. H. Lin. (55—A-43)

Theory of Yield Point and Transition Temperature of Mild Steel, by F. Forscher. (55—A-42)

Comparison of Slip-Line Solutions With Experiment, by E. G. Thomsen. (55—A-51)

Analysis of Creep in Rotating Disks, by A. M. Wahl. (55—A-46)

Plastic Deformation of Semi-Infinite Beams Due to Transverse Impact, by M. F. Conroy. (55—A-49)

On the Ideally Plastic Indentation of Inset Rectangular Bands, by E. W. Ross, Jr. (55—A-52)

Stiffness of Curved Circular Tubes With Internal Pressure, by P. G. Kafka and M. B. Dunn. (55—A-32)

Vibrations of Cylindrical Shells With Rotatory Inertia and Shear, by T. C. Lin and G. W. Morgan. (55—A-59)

On the Wake Energy of Moving Cascades, by N. H. Kemp and W. R. Sears. (55—A-33)

A Suction Device Using Air Under Pressure, by L. F. Welanetz. (55—A-38)

Stress Functions for Rotating Plates, by P. G. Hodge, Jr. (55—A-5)

High-Frequency Extensional Vibrations of Plates, by T. R. Kane and R. D. Mindlin. (55—A-50)

Sudden Rotary Disturbance in an Elastic Plate, by J. N. Goodier and W. E. Jahsman. (55—A-47)

Effect of Hub Radius on Vibrations of a Uniform Bar, by W. E. Boyce. (55—A-44)

Method of Stepwise Integration in Problems of Impact Buckling, by A. F. Schmitt. (55—A-37)

Free Convective Thermal and Mass Transfer From a Vertical Flat Plate, by E. V. Somers. (55—A-48)

Oil-Film Properties With Reference to Unbalance Vibration, by A. C. Hagg and G. O. Sankey. (55—A-45)

### Design Data and Methods

Computation of Roll Force and Torque in Cold-Rolling, by P. W. Whitton.

Nomogram for Ratios of Octahedral to Maximum Shearing Stresses, by O. P. Kharbanda.

### Brief Notes

Transient Temperature Rise in a Semi-Infinite Solid, by M. M. Atalla and K. Preston, Jr.

The Mean Stress Around a Small Opening in a Uniformly Loaded Plate, by J. S. Brock.

Note on Torsion With Variable Twist, by Eric Reissner.

Vibrations of Cylindrical Shells With Stiffeners, by M. L. Baron.

The Orthogonal Property—A Proof by Virtual Work, by R. P. N. Jones.

Symmetric Flexural Vibrations of a Clamped Circular Disk, by H. Deresiewicz.

### Discussion

Discussion on previously published papers by Salomon Levy; B. A. Boley and C. C. Chao; N. J. Hoff; A. C. Eringen; G. C. K. Yeh and Johann Martinek; A. J. Durelli and J. Barriage; and F. R. Arnold.

### Book Reviews

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# Comments on Papers

## Including Letters From Readers on Miscellaneous Subjects

### The Hoover Commission

**Comment by John H. Davidson**[1]

THIS comment is made to protest the use of space in MECHANICAL ENGINEERING for such articles as the one entitled "Some Major Findings of the Hoover Commission."[2] My objection lies in the fact that this article is of a political nature, with no special reference to the engineering profession. I do not mean to imply that mechanical engineers should not be interested in governmental affairs, but certainly their technical magazine should not be used as the agency to present any side of a controversial political matter.

Although the author states that "a few examples of interest to the engineering profession will be cited," an examination of the article fails to disclose anything that could be said to be of special interest to engineers in a professional sense.

Certainly the lengthy discussion on Federal medical care and management of the Executive Branch has no place in an engineering magazine. The section called "Operation of Commercial and Industrial Facilities" is appropriate in title only, since its content is concerned with the fiscal policies of military transportation and commissary organizations. The last sentence of this section refers to income taxes and is certainly not appropriate for submission to a trained professional group banded together to advance the engineering art.

This sentence: "In effect, the Government is busy actively promoting the killing of the geese that lay the golden eggs," is most certainly an argumentative statement with political references.

I am sure that I speak for a great number of engineers, probably of differing political beliefs, when I state that I am a member of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS only because I have a serious technical interest in this branch of engineering.

Because MECHANICAL ENGINEERING is our official magazine I do think it should not argue either or both sides of such issues.

[1] Industrial Consultant, Portland Ore. Assoc. Mem. ASME.

[2] "Some Major Findings of the Hoover Commission," by S. C. Hollister, MECHANICAL ENGINEERING, vol. 77, February, 1956, pp. 150–153.

### Synthetic Fuels

**Comment by Richard C. Corey**[3]

THE authors[4] have competently analyzed past, present, and predicted energy demands in this country and have concluded that commercial production of synthetic liquid and gaseous fuels from coal will begin within the next 10 years, and increase sharply thereafter to supplement the dwindling reserves of oil and gas.

They emphasize that the demand for synthetic liquid and gaseous fuels will be based upon the energy demands necessary to maintain living standards and not upon the comparative costs of natural and synthetic fuels. This is a sound basis of argument. However, the authors also take cognizance of the necessity of continuous research and development to reduce the unfavorable price differentials that exist between the natural and the synthetic fuels. In other words, they recognize the inevitability of commercial production of synthetic fuels from coal, and look to research and development to place these fuels on the market at a price comparable with that of the natural products.

#### Price Differentials

Some progress has been made in recent years to reduce the price differentials between synthetic and natural oils and gas. The best estimates indicate a differential of about 16 cents per gal between gasoline at the refinery and Fischer Tropsch gasoline, and 22 cents per gal in the case of gasoline from coal hydrogenation. The thermal efficiencies of the coal-to-oil processes are about 40 per cent as compared to about 90 per cent in modern petroleum refineries, and therefore point to considerable room for improvement in these processes.

Current Bureau of Mines research programs on pressure gasification of coal, the use of metal oxides and of chelates to furnish oxygen for gasification, hot-gas recycle in the Fischer-Tropsch process, high-temperature coal hydrogenation in a single step, hot-carbonate gas scrubbing, and other related studies all are directed to higher process efficiencies and lower feed-materials requirements. The effect of a large potential market for light oils in gas-turbine-powered automobiles and aircraft upon the price of Fischer-Tropsch oils cannot be ignored as a factor in reducing differentials.

#### Pipe-Line Gas

In connection with pipe-line gas, estimates of between 45 and 85 cents per million Btu have been made for methane from coal, via gasification followed by methanation. Research and development by the Bureau of Mines on methanation reactors and catalysts have notably improved the outlook for high specific reactor capacity and long catalyst life.

These findings, together with continuing improvements in technology of coal gasification and gas purification, are contributing appreciably to lower costs for pipeline gas from coal. Another approach in this direction is the possibility of securing high gas yields by the direct hydrogenation of dry coal.

One of the most attractive commercial possibilities, which is entirely feasible, is a flexible process that would produce controlled ratios of liquid fuels and hydrocarbon gases. During periods of high demand for pipeline gas, the product from such a plant would be predominantly gas, and predominantly liquids as the demand ratio changed.

No discussion today of fuel or chemical technology would be complete without mentioning nuclear fission as a source of process energy. Recent engineering estimates in connection with the use of U-235 to furnish energy for coal gasifica-

[3] Chief, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa. Mem. ASME.

[4] "Future of Synthetic Liquid and Gaseous Fuels," by H. R. Batchelder and H. W. Nelson, MECHANICAL ENGINEERING, vol. 78. January, 1956, pp. 11–14.

tion indicate substantial savings in the cost of synthesis gas. The design problems associated with a nuclear-heated gasifier are manifold, but in so far as can be seen at present, they are not insurmountable.

A growing interest in all of these matters by the coal, gas, and chemical industries portends even greater efforts to bring liquid fuels and methane from coal within reach of the user in the next few years.

### Comment by L. L. Newman[5]

THE authors are commended for examining the rate of growth of energy demand, particularly for liquid and gaseous fuels, the supply and availability of natural fuels, and other factors that will determine future production of fluid fuels from coal.

In general, the projections, estimates, and other material presented seem sound and logical. The conclusions on atomic energy and solar energy are in line with the views expressed by those Bureau of Mines employees who have had an opportunity to review this paper.

In Fig. 1 the authors show the actual growth in population from 1946 to the present time has exceeded all predictions.

Similarly, in Fig. 3 they show that during the same period actual production and demand for petroleum products have exceeded the forecasts. If these trends should continue, the demand for all forms of energy given by the authors in Fig. 2 would be exceeded and in 1975 would go beyond the report of the President's Materials Policy Commission. The prediction of the authors therefore may be considered quite conservative; the demand for petroleum products projected in Fig. 4 may be similarly considered.

In view of the fact that the actual production of petroleum from 1946 to the present exceeded the forecast, we may confidently expect that with technologic improvements, production will continue to exceed 1955 forecasts. If so, the curves for projected production of petroleum products also will be higher.

The effect of elevating the curves by, say, 1 million barrels of petroleum products per day would only postpone the requirements for synthetics-from-coal from 1965 to about 1970. A shift of 5 years should in no way change the conclusions of the authors; consequently, our efforts to improve existing processes and develop new methods for producing high Btu gas and synthetic-liquid fuels from coal must not be relaxed.

[5] Assistant Chief Coal Technologist, Bureau of Mines, United States Department of the Interior, Washington, D. C.

### Comment by H. H. Storch[6]

AS A market survey of the potential demand for synthetic liquid and gaseous fuels, this paper is of interest and somewhat unique in that the "price" is estimated in terms of manpower and materials for plant construction. The "timing" estimates are reasonable and based on the judgment of competent technical experts.

The paper would be of greater interest if the authors presented their views concerning the relative merits of the different processes for conversion of coal-to-oil and gas, and commented on the research and development effort needed during the next 10 or 15 years to provide adequate new technical knowledge. These are relatively controversial subjects and the writer can understand the authors' disinclination to discuss them. They are, however, of great national importance, and need active consideration and discussion. Very little, if any, research and development on synthetic fuels from coal is currently being done by industry, and the Bureau of Mines program has been greatly curtailed.

## Pipe Welding

### Comment by H. B. Fishman[7]

THE Electric Boat Division of General Dynamics Corporation felt the necessity of being able to make sound root-pass welds in high-temperature, high-pressure pipe systems, and other pipe systems which require exceptionally high-quality welds.

The welding fabricator who is striving for better quality control and lower costs can readily see the advantages in simplifying the welding of the root pass. The use of the consumable-insert process and its advantages as outlined by the author[8] have been found valuable in our work. Since only average welding skill is required we have been able to produce welds with good reproducibility. The insert weld has eliminated the use of a permanent backing ring and its inherent crevice. In welding Type 347 stainless steel we obtain excellent control of percentage dilution and therefore ferrite content to produce fissure-free welds. For certain applications such as primary coolant systems for atomic power plants, where the permanent backing ring is not permissible, the consumable insert was the most desirable solution that we could find for our production work. This has reduced both our fabrication and inspection problems. The advent of the consumable insert has permitted many design changes which produce a better product more quickly for less money.

[6] Director, Basic Research Department, Stamford Laboratories, Research Division, Stamford, Conn.

[7] Electric Boat Division of General Dynamics Corporation, Groton, Conn.

[8] "Consumable-Insert Technique for Pipe Welding," by R. D. Thomas, Jr., MECHANICAL ENGINEERING, vol. 78, February, 1956, pp. 145–149.

### Author's Closure

The author appreciates the comments of Mr. Fishman. Surely the industrial application of the process in nuclear reactors is excellent testimony to its efficacy. There is reason to anticipate an ever-widening field of application as engineers recognize that high-quality root-pass welds can be specified without entailing an exhorbitant cost.

R. David Thomas, Jr.[9]

## Nodular Cast Iron

### Comment by S. B. Bailey[10]

THE authors' test results[11] with nodular-graphite cast-iron valve bodies are excellent, but the writer is not at all sure that they are justified in comparing them with the results obtained from a 0.2 per cent carbon nickel-free cast steel. It is no more difficult or costly to put $1\frac{1}{2}$ per cent of nickel in cast steel than it is to put it in cast iron, and its addition to the steel would have a very similar effect in raising the tensile strength, reducing the ductility, and lowering the temperature at which the material first begins to give brittle fractures under impact.

In the writer's opinion, the authors have clearly demonstrated the suitability of nodular-graphite cast iron for valve bodies, but they have not demonstrated its superiority to cast steel, for they have compared an expensive kind of nodular iron with one of the cheapest grades of cast steel.

It is important not to overlook the effects of the nickel in the authors' nodular-iron valves, because the nickel does

[9] Executive Vice-President, Arcos Corporation, Philadelphia, Pa.

[10] Mechanical Engineering Liaison Officer, United Kingdom Scientific Mission, Washington, D. C.

[11] "Bending and Impact Tests of Cast-Iron, Cast-Steel, and Nodular-Iron Valve Bodies," by J. O. Jeffrey and R. H. Hanlon, MECHANICAL ENGINEERING, vol. 78, January, 1956, pp. 23–27, 30.

not have to be present in nodular cast iron. In Britain and Germany the material is now being produced on a commercial scale by direct magnesium treatment in a pressure vessel, a method which can reduce the cost of treated metal in the ladle by as much as 25 per cent. Metal produced in this manner would be the kind of metal one normally would compare with a cast carbon steel, and its tensile-strength and its low-temperature-impact properties would be inferior to those of the authors' material.

It would appear that the choice between nodular-graphite cast iron and cast steel for valve bodies will be made on economic grounds where bolted flanges are used. For all-welded pipe lines the nodular iron will be at a serious disadvantage, for it seems unlikely that a truly ductile weld will be developed for this material.

## Authors' Closure

Our tests were conducted on the basis of using commercially available products; thus we purchased steel valves of a popular make on the open market and, without particular regard to their exact chemistry, used them as representative of generally purchased 150-psi steel valves.

The fact is that they are substantially nickel-free, which is general practice.

It might be pointed out that the influence of small percentages of nickel up to $1^1/_2$ per cent is not particularly effective in raising the tensile strength in cast steel, as the following shows.

Since the chemistry of ductile iron and steel are basically different in carbon and silicon content, it is difficult to compare each material on a chemical basis alone. Not only must the nickel be considered on the mechanical properties of nodular iron, but also the effect of silicon, manganese, and other elements. The yield strength of annealed ductile iron may be increased by adding silicon; in fact $^1/_2$ per cent silicon will raise its yield strength by 5600 psi.[12] Therefore we are not limited to adding nickel alone to increase the yield strength of nodular iron.

The tests were made for several purposes, one of which was to determine what would happen if the valves were heated and then suddenly quenched. Under these conditions, the transition temperature would have no effect on the results. Therefore, in this particular test, the effect of nickel on the transition temperature of either steel or ductile iron would have little effect.

Nickel will raise the tensile and yield strength of annealed ductile iron. Since other elements like silicon will raise these properties even more markedly, it is not necessary to rely on nickel alone.

Subsequent drop-weight tests have developed the data, confirmed by Pellini,[13] that the optimum amount of nickel for toughness is zero.

The presence of $1^1/_2$ per cent nickel in cast steel will have little effect on its tensile or yield properties. For this reason we would not expect the steel-valve test results to be much different, even if a nickel steel were used, as shown by Table 1 of this closure.[14] Therefore the presence of approximately 1 per cent nickel in our ductile-iron valves, and its absence in the cast-steel valves would not invalidate our test results or conclusions.

From Table 1 it can be seen that the effect of nickel is minor on the tensile strength, raises the elongation, and does lower the transition temperature in cast steels.

When determining costs, many factors must be considered. Some of these factors are (*a*) temperature of pouring metal and hence foundry practice, (*b*) castability, (*c*) number of rejected castings, (*d*) melting unit and others.

To be in a position to compare the relative costs of the materials, all factors of cost must be considered and not just the presence of one chemical element.

One of the most important aspects Mr. Bailey has overlooked is the relative corrosion resistance of ductile iron versus steel. It is suggested that he read the paper "Ductile Iron—Corrosion Resistance in Sea Water and Petroleum Tanker Services" by Bernard de la Bruniere and Michel Paris given before the National Association of Corrosion Engineers in New York, N. Y., March 15, 1956, which indicates that ductile-iron pipe is more resistant to corrosion occurring in petroleum tankers than steel pipe under the specified condition of testing.

Ductile iron is produced in the United States in both nickel-containing and nickel-free types; therefore it is possible to obtain either type. The effect of nickel on ductile iron is given in Table 2, herewith.[12]

In regard to the comment concerning bolted versus welded-valve construction, most of 150-lb valves are used as flanged, bolted to flanges in this pressure range.

**Table 1 Properties of Cast Steel**

Chemical Composition and Heat-Treatment of Cast Steels

| Ni | C | Mn | Si | Deox | Heat-treatment |
|---|---|---|---|---|---|
| 0 | 0.31 | 0.66 | 0.38 | 0.05 Al | Heated 2 hr at 1800 F and air-cooled, then heat-treated at 1625 F for 1 hr, AC 1200 F, 2 hr AC |
| 1.55 | 0.30 | 0.68 | 0.36 | 0.04 Al | Heated 2 hr at 1800 F and air-cooled, then heat-treated at 1575 F 1 hr AC 1200 F, 2 hr AC |

Mechanical Properties of Cast Steel

| Ni, per cent | Tensile, psi | Yield, psi | Elong, per cent | R of A, per cent | Bhn | Vee-notch Charpy, ft-lb | Transition temp, deg F (15 ft-lb–temp) |
|---|---|---|---|---|---|---|---|
| 0 | 76000 | 47000 | 25 | 44 | 144 | 34 | Above 32 |
| 1.55 | 77000 | 50000 | 32 | 56 | 150 | 34 | 0 |

**Table 2 Effect of Nickel on Ductile Iron**

Influence of Nickel and Silicon on Properties of Ductile Iron

| Increase of element | Tensile, psi | Yield, psi | Elong, per cent | R of A, per cent | Bhn |
|---|---|---|---|---|---|
| 1% nickel..... | + 5000 | + 6000 | −1.0 | −2.3 | + 7.0 |
| 1% silicon..... | +11000 | +11200 | −3.0 | −2.8 | +29.0 |

Mechanical Properties of Ductile Iron

| Ni | Tensile, psi | Yield, psi | Elong, per cent | R of A, per cent | Bhn |
|---|---|---|---|---|---|
| 0 | 70000 | 52080 | 22 | 26 | 162 |
| 1.5 | 77500 | 61000 | 20.5 | 22.6 | 172.5 |

J. O. Jeffrey.[15]
R. H. Hanlon.[16]

[12] "Prediction of Mechanical Properties From Chemical Composition for Fully Annealed Ductile Cast Iron," by C. C. Reynolds, C. M. Adams, and N. A. Taylor, Transactions of the American Foundrymen's Association, vol. 61, 1953, pp. 510–515.

[13] "Notch Ductility of Nodular Iron," by W. S. Pellini, G. Sandoz, and H. F. Bishop, Trans. ASM, vol. 46, 1954, pp. 418–445.

[14] "Metal Data," by S. L. Hoyt, Reinhold Publishing Corporation, New York, N. Y., 1952, p. 263.

[15] Professor of Engineering Materials, Cornell University, Ithaca, N. Y.

[16] Executive Engineer, The Kennedy Valve Manufacturing Company, Elmira, N. Y. Mem. ASME.

# Reviews of Books

## And Notes on Books Received in Engineering Societies Library

### Water-Hammer Analysis

WATERHAMMER ANALYSIS. By John Parmakian. Prentice-Hall, Inc., New York, N. Y., 1955. Cloth, 6¼ × 9¼ in., tables, figs., references, index, 161 pp., $6.50.

**Reviewed by S. Logan Kerr**[1]

THIS book by John Parmakian is a most interesting addition to the literature on water hammer that has been published in English over the last 25 years, mostly under the sponsorship of The American Society of Mechanical Engineers.

As the author states, the book had its origin in courses of instruction for graduate and undergraduate students of the University of Colorado, but has been expanded in scope to make it usable to the designing engineer who is faced with practical problems involving water hammer.

Chapters 1 and 2 give an exposition of both the rigid-column theory and the elastic water-column theory and are of interest to those who have familiarity with the higher order of differential equations and represent the summation of the early theories and those which were developed from the experimental work of Joukovsky and the theoretical analyses of Allievi, the former having been published in English by the American Water Works Association in 1904, and the latter translated into English by E. E. Halmos and published under the auspices of the American Society of Civil Engineers in 1925.

Both of these treatises are fundamental in our present-day knowledge of water-hammer theory.

The chapter on velocity of water-hammer waves is of interest as it covers various types of material used in pressure conduits.

Chapters 4 and 5 give a concise summary of the water-hammer phenomenon with rapid closures, while chapter 6 analyzes these for slower movements of the control valves or turbine gates.

One of the great values of this book is the exposition of the graphical method of solving water-hammer problems which was developed initially in Europe and is attributed generally to Lowy in Austria, Schnyder in Switzerland, and Bergeron in France. Various translations and amplifications of these basic theories have been made by a number of authors in the United States, Canada, and Great Britain. Mr. Parmakian, however, has summarized the graphical solution of various types of problems chapter by chapter, so that the less complex problems can be analyzed with some degree of accuracy for preliminary design studies.

Chapters 11 and 12, covering water-hammer problems in pump discharge lines, are of considerable interest, but they in turn deal only with greatly simplified installations and omit the analyses of the more complex projects which are becoming more and more common as municipal and other water supplies are required to go farther and farther for their source of water.

The effect of friction has also been covered in chapter 13 and follows the teachings of Schnyder and Bergeron to a large extent.

The section on approximate methods should be followed with a great deal of caution when studying complex conduits as serious errors may result from over-simplification.

Chapter 16 on the discharge characteristics of gates and valves still maintains the relationship between areas and valve positions rather than flow versus valve positions. This is an important factor since the flow is not directly proportional to areas throughout the stroke of any control valve.

The chapter on surge tanks and air chambers is of interest in showing the benefits to be gained from such types of installations.

In general the book omits references to all other remedial devices and particularly the effect of the parting and rejoining of the water column which is present in many installations both of pump-discharge lines and of hydraulic-turbine penstocks.

The use of the dimensionless relations has been followed in practically all of the illustrations where the head in the graphical analysis is taken as the ratio of the water-hammer head to the normal head and the velocity of flow has been taken as the ratio of the transient flow to the design flow. To many outside of academic circles, who are faced with water-hammer problems, the use of actual units, such as feet of head, velocities in feet per second, and time in seconds, gives a feeling of physical significance that the dimensionless approach omits.

So many of the treatises on water hammer have been based on theoretical analyses that there is a need for comparisons between theoretical studies and actual test results obtained on the completed installations. In the preface the author states, "Sufficient field-test data have been obtained at these structures to demonstrate the reliability of the methods of analysis described in the text." If some of these actual results had been included in the book as a matter of comparison with theoretical analyses it would have been most reassuring to those who are engaging in the solution of water-hammer problems on major projects.

The author's bibliography is an interesting selection of the outstanding contributions to the subject. With the exception of three references to French publications and one to a German publication, all of the 47 articles and books referred to are in English and should be readily available to those who wish to study the problem in greater detail.

[1] Chairman, ASME Hydraulic Division Committee on Water Hammer; Consulting Engineer, Flourtown, Pa. Fellow ASME.

## Books Received in Library

ASTE ANNUAL COLLECTED PAPERS, 1956. Published by American Society of Tool Engineers, Detroit, Mich. Various pagings, 8½ × 11 in., loose-leaf manual. $7.50. Ceramic tooling, drawing of titanium, applications of diamond tools, equipment replacement, computers for machine-tool control, training and development of engineers, automation, and a wide range of additional subjects are covered in the fifty-one papers included. The volume also contains a panel discussion on carbide die problems, research reports on cemented borides and methods of applying cutting fluids, and a summary of a recent ASTE survey on impact of automation on production in the near future. Many of the papers are illustrated; some include references.

ANNUAL REPORT ON THE PROGRESS OF RUBBER TECHNOLOGY. Volume 19, 1955. Published by the Institution of the Rubber Industry, London, England, 158 p., $7^1/_4 \times 9^7/_8$ in., bound. 21s. A critical review of the literature covering advances in cable and electrical insulation, synthetic rubber, testing and equipment, machinery and appliances, processes and materials, and in the manufacture of various types of rubber goods. One section deals with the use of rubber as a road surfacing material.

CALCULATION OF CHANGE GEAR RATIOS. By Eric H. Wang. 1954, 116 p., $8^1/_4 \times 11$ in., spiral binding. Available from the author, 601 Monroe Drive, Xenia, Ohio. $3.50. The problem of finding two, four, six, and more gear ratios that will approach a desired ratio in the form of a decimal is an old one. The author here provides a systematic development of simple principles. Factor tables and sample work charts follow a step-by-step explanation of the methods. The most suitable practical ratio within a given permissible error may be found or, if wanted, the ratio with the smallest error.

COMMON SENSE IN RESEARCH AND DEVELOPMENT MANAGEMENT. By George W. Howard. 1955. Vantage Press, New York, N. Y. 104 p., $5^1/_4 \times 8^1/_4$ in., bound. $2.75. This is an impartial description of current practice, based on visits to industry, government, and university research establishments in the United States, Canada, and Europe. The activities described include organization; selection and professional development of personnel; duties of the director; planning and checking progress; internal communications; and technical services—library, laboratory, stenographic, etc. A ten-page annotated bibliography is included.

CONTROL OF QUALITY IN THE PRODUCTION OF WROUGHT NON-FERROUS METALS AND ALLOYS. Part 3. The Control of Quality in Heat Treatment and Final Operations. (Monograph and Report Series, No. 17), 1955, The Institute of Metals, London, England, 104 p., $8^1/_2 \times 11^1/_8$ in., bound. $2.50. Five of the six papers in this monograph deal with the heat-treatment, finishing, inspection, and testing of rolled, extruded, and drawn aluminum and aluminum alloys; copper and aluminum rod and wire; copper and copper-base alloys; light-alloy drop forgings; and wrought nickel and nickel alloys. The sixth paper is a review of methods of aeronautical inspection of wrought products as conducted by the British Ministry of Supply.

DIECASTING DIE DESIGN. By H. K. Barton and L. C. Barton. 1955, The Machinery Publishing Co., Ltd., London, England, 158 p., $5^1/_2 \times 8^3/_4$ in., bound. Available from The Industrial Press, New York, N. Y. $3. Primarily intended for practicing diecasters, this book analyzes the various features of dies and shows how their design and use under various operating conditions influence the quality of castings. Detailed consideration is given to runners and gates, ejector mechanisms, fixed cores, die inserts, retractable cores, insert preloading devices, thermal balance in dies, and operational factors affecting cavity disposition. The last three chapters deal with the effect of variant die designs on ease of maintenance, finishing, and dimensional accuracy.

DYNAMICS OF MACHINERY. By James B. Hartman. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 283 p., $6 \times 9^1/_4$ in., bound. $7.50. Emphasizing the development of the ability to apply fundamental principles to the solution of problems of machine design and analysis, this book deals with such selected topics as mechanical vibrations, balancing of machinery, engine dynamics, mechanical transients, and the dynamics of automatic control systems. Vector analysis, Fourier series, Laplace transforms, and other mathematical techniques not usually encountered in undergraduate courses are introduced as needed. Problems are provided at the end of each chapter, and a set of special projects designed to develop a professional approach to engineering problems is contained in an appendix.

## Library Services

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GENERALIZED THERMODYNAMIC PROPERTIES OF PURE FLUIDS. By A. L. Lydersen, R. A. Greenkorn, O. A. Hougen. Report No. 4, Engineering Experiment Station, College of Engineering, University of Wisconsin, Madison, Wis. 99 p., $8^1/_2 \times 10^7/_8$ in., spiral binding, $3.50. By the use of third parameter, the critical compressibility factor, the theory of corresponding states has been extended for both gaseous and liquid phases of pure compounds. Extensive tables are presented covering a range of reduced temperatures and reduced pressures at regular intervals. The tables are based on a systematic selection from $pv\,T$ data of 59 organic compounds (hydrocarbons, etc.) and 23 inorganic compounds including water. Several special tables are also included and methods of use are demonstrated by numerical examples.

HANDBUCH DES KOKEREIWESENS. Vol. 1. By Otto Grosskinsky. 1955, Karl Knapp Verlag, Düsseldorf, Germany, 547 p., $6^3/_4 \times 9^1/_2$ in., bound. 76 DM. This is the first volume of a two-volume set on coking practice intended to replace and bring up to date the now out-of-print International Handbook of the By-Product Coke Industry. Written by authorities in the field, the six main sections deal with: the importance of coking practice; the characteristics of coals and coking coals; the coking plant; the characteristics of coke; test methods for coal and coke; energy economics in the coking plant.

HIGH-TEMPERATURE TECHNOLOGY. Sponsored by The Electrochemical Society, Inc., editor-in-chief, I. E. Campbell. 1956, John Wiley and Sons, Inc., New York, N. Y. 526 p., $5^3/_4 \times 9^1/_4$ in., bound. $15. Contributions by thirty-five specialists are presented in four sections devoted to the development of refractories; techniques; materials; methods; and measurement. The discussion of materials is concerned mainly with oxides, carbides, nitrides, silicides, sulphides, and cermets, but also includes a brief treatment of metallic materials. In dealing with methods, sintering is discussed at length, and both conventional and new types of furnaces are described. The section on measurements covers various specialized mechanical and physical property tests and optical and x-ray techniques.

INDEX MATHEMATISCHER TAFELWERKE UND TABELLEN. Compiled by Karl Schütte. 1955, Verlag R. Oldenbourg, Munich, Germany, 143 p., $5^3/_4 \times 8^3/_8$ in., bound. 14.50 DM. This is a list of about 1200 tables, giving only authors, titles, and place and date of publication. It is a guide to tables for practical and numerical calculating, logarithms of circular functions, natural values of circular functions, elliptic functions, integrals, and other purely mathematical tables, as well as to tables from other branches of science such as physics, chemistry, astronomy, geodesy, geophysics, and meteorology. Chapter headings and subdivisions of chapters are given in both German and English.

INTRODUCTION TO PLASTICITY. By Aris Phillips. 1956, The Ronald Press Company, New York, N. Y. 230 p., $6 \times 9^1/_4$ in., bound. $7. A treatment of metal plasticity, written from the viewpoint of the stress analyst and intended for advanced students and practicing engineers. The first six chapters deal with one-dimensional problems: the behavior of an indeterminate truss as influenced by the plastic behavior of its members; plastic design of beams and frames; plastic bending; deflections of statically determinate and statically indeterminate beams and frames; and the theory of curved bars. The last three chapters deal with problems of combined stress: the stress-strain relations of plasticity, plastic design of structures, and strain hardening. Proofs of some of the theorems employed in the text are given in the appendix, and a number of problems are supplied at the end of the book.

LEGAL PROBLEMS IN ENGINEERING. By Melvin Nord. 1956, John Wiley and Sons, Inc., New York, N. Y. 391 p., $6 \times 9^1/_4$ in., bound. $7.50. The section of this book devoted to specifically engineering-legal problems covers construction contracts and specifications; governmental regulation of business; patents, copyrights, and trademarks; and air and stream pollution. In addition, the book includes a section dealing with engineering ethics and professional registration, and another explaining the legal principles involved in contracts in general, sales, insurance, workmen's compensation, partnerships, municipal corporations, and other subjects of interest to engineers. Cases used to illustrate the discussion are given in condensed form and simplified language.

PETROLEUM PRODUCTION ENGINEERING: OIL FIELD DEVELOPMENT. Fourth edition, 1956. By Lester C. Uren. McGraw-Hill Book Company, Inc., New York, N. Y. 792 p., $6 \times 9^1/_4$ in., bound. $12. This volume, one of a series of three volumes providing a thorough survey of the subject, is a detailed discussion covering the planning and conducting of a field-development program, the drilling of wells, and the exploitation of fields up to the point where they are ready to produce. Among the many processes, methods, and types of equipment discussed are well spacing, derricks, churn and rotary drilling, well casing, logging, surveying, and well records. In this edition, some sections have been rewritten, and new material covering advances in equipment and methods has been added. Selected bibliographies are appended to each chapter.

PRODUCTION CONTROL. Text and Cases. By William Voris. 1956, Richard D. Irwin, Inc., Homewood, Ill. 413 p., $6 \times 9^1/_4$ in., bound. $7.20. This is a presentation of basic

principles and their applications in intermittent and continuous manufacturing, with considerable emphasis on company organization and on the interrelationships between production control and other manufacturing functions. Control in a small company is treated separately, and material is included on the automatic factory, computers, operations research, and linear programming. Case problems from actual companies are used to illustrate the discussion.

RESISTANCE OF MATERIALS. By F. B. Seely and J. O. Smith. Fourth edition, 1956, John Wiley and Sons, Inc., New York, N. Y. 459 p., $5^1/_2 \times 8^5/_8$ in., bound. $6.50. Part 1 of this standard text consists of the basic topics usually included in the subject: relations among loads, stresses, and deformations; stresses in beams; statically indeterminate members; dynamic loads, etc. Part 2 deals with such additional topics as composite beams, unsymmetrical bending, continuous beams, and elastic vibration of load-resisting members.

SAFETY MANAGEMENT. Accident Cost and Control. By R. H. Simonds and J. V. Grimaldi. 1956, Richard D. Irwin, Inc., Homewood, Ill. 555 p., $6 \times 9^1/_4$ in., bound. $7.80. Of special interest to engineers are the chapters in this book dealing with the safety aspects of plant layout, machinery, boilers, electricity, materials handling, storage, new-product development, and wastes disposal. As a whole, the book is a comprehensive treatment of principles, supplemented by numerous practical suggestions and illustrated by selected case histories. Among the major topics treated are organization of a safety department, accident-cost analysis, health hazards, protective equipment, and employee selection and training. Appendixes list common industrial health hazards and give properties of selected flammable materials.

SCHALL UND SCHWINGUNGEN IN FESTKÖRPERN. (VDI Berichte Volume 8) 1956, VDI-Verlag, Düsseldorf, Germany. 183 p., $8^1/_4 \times 11^5/_8$ in., paper. 48 DM. The thirty-five papers included in this symposium deal with noise and vibration as transmitted by solid bodies. These papers are grouped under four main headings: structure-borne sound in building materials; structure-borne noise in relation to engineering design; damping problems; measurement of structure-borne noise. Several of the papers are in English, and the others have brief English summaries.

STAUBBEWEGUNGEN IN GRENZSCHICHTEN. VDI Berichte, No. 6, 1955. Verein Deutscher Ingenieure, Düsseldorf, Germany. 56 p., $8^1/_4 \times 11^5/_8$ in., paper. 10.50 DM. A group of twelve papers dealing with various aspects of the motion of dust at boundary layers: distribution of particles; operation of mechanical dust separators; deposition and sedimentation phenomena; pneumatic-transportation investigations; hydrodynamic phenomena in turbulent gas layers; etc.

STRENGTH OF MATERIALS. Part 2. Advanced Theory and Problems. By S. Timoshenko. Third edition, 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 572 p., $6 \times 9^1/_4$ in., bound. $7.50. The second volume of the revised edition of this standard work for graduate students, designers, and research engineers includes a considerable amount of new material. Major changes have been made in the chapters devoted to torsion, plastic deformation, and the mechanical properties of materials. In the latter chapter, information for the proper selection of working stresses has been presented in considerable detail. New references, figures, and problems have been inserted throughout the text.

STUDIES OF BOUNDARY VALUE PROBLEMS. Parts 1–3. By Sven T. A. Ödman. Swedish Cement and Concrete Research Institute (Proceedings, No. 20, No. 24, No. 25), Stockholm, Sweden, 1953, 1955. 44 p., 283 p., 27 p., $6^7/_8 \times 9^7/_8$ in., papers. 8, 35, 5 Sw. crowns. Part 1 of this treatise surveys commonly used minimum methods for solving boundary-value problems and describes the orthogonal method for calculating a first approximation to a solution of a partial differential equation with homogeneous boundary conditions. Part 2 deals with the application of the latter method to the natural vibration of rectangular plates and presents tables of the 36 lowest characteristic functions of rectangular slates varying in side-length ratio and for four sets of boundary conditions. Part 3 discusses methods of solution of the problem of an oblique plate transversely loaded.

SYMPOSIUM ON BASIC EFFECTS OF ENVIRONMENT ON THE STRENGTH, SCALING, AND EMBRITTLEMENT OF METALS AT HIGH TEMPERATURES. (Special Technical Publication No. 171) American Society for Testing Materials, Philadelphia, Pa. 114 p., $6 \times 9$ in., paper. $2.75. The six papers making up this symposium deal with the following subjects: the role of thin surface films in the deformation of metal monocrystals; structure of oxides on high-temperature alloys at 1500 F; effect of strain on the oxidation of nickel-chromium heater alloys; intergranular oxidation in type 310 stainless steel; oxidation-resistant scales on molybdenum-base alloys; and oxidation at elevated temperatures. Discussions and lists of references accompany each paper.

TABLE OF HYPERBOLIC SINES AND COSINES. ($x = 2$ to $x = 10$.) (Applied Mathematics Series, National Bureau of Standards, no. 45, 1955.) Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 81 p., $7^7/_8 \times 10^1/_8$ in., paper. $0.55. This table provides values of hyperbolic functions in the range from $x = 2$ to $x = 10$ at intervals of .001 to nine significant figures. It supplements previously published tables which covered the range 0 to 2 at intervals of .0001 and the range 0 to 10 at intervals of .1.

TABLE OF THE DESCENDING EXPONENTIAL. ($x = 2.5$ to $x = 10$.) (Applied Mathematics Series, National Bureau of Standards, no. 46, 1955.) Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 76 p., $7^7/_8 \times 10^1/_8$ in., paper. $0.50. In an earlier set of tables (1939) the descending or negative exponential $e^{-x}$ was tabulated from $x = 0$ to $x = 2.5$ at intervals of .0001, and for the range $x = 1$ to $x = 100$ at intervals of 1. The present table gives values in the range $x = 2.5$ to $x = 10$ at intervals of .001, to 20 decimal places.

TASCHENBUCH DER HOCHFREQUENZTECHNIK. Edited by H. Meinke and F. W. Grundlach. 1956, Springer-Verlag, Berlin, Germany, 1408 p., $5^1/_8 \times 8$ in., bound. 69 DM. A comprehensive handbook on high-frequency engineering containing an extensive compilation of curves, formulas, and basic data with special reference to communications applications. Theory, design, and operating characteristics are presented in the twenty-five sections written by authorities in the special fields. Electronics applications other than in communications are not included. A detailed table of contents and an extensive subject index are provided.

TECHNISCHE MESSUNGEN AN STAUBSYSTEMEN. VDI Berichte, no. 7, 1955. Verein Deutscher Ingenieure, Düsseldorf, Germany. 82 p., $8^1/_4 \times 11^5/_8$ in., paper. 12.50 DM. Technical measurements in industrial dust systems are treated from various standpoints: sampling devices; effect of errors on accuracy of measurement; determination of particle size; electrical properties of dusts; dust and fume problems; special devices and applications.

THEORETICAL HYDRODYNAMICS. By L. M. Milne-Thomson. Third edition 1955, The Macmillan Company, New York, N. Y. 632 p., $6 \times 9^1/_2$ in., bound. $9.80. The object of this book is to give a thorough and clear introduction to the mathematical theory of fluid motion which will be applicable to both hydro and aerodynamics. The presentation is based on vector methods and the complex variable, and in order to make the book self-contained, concise treatments of both have been included. The principal changes in this edition, apart from rearrangements of material and new methods of presentation, are the following additions: Darwin's interpretation of virtual mass; Shiffman's method of reflection across free streamlines; and John's treatment of potential flow with a free surface.

THEORY AND PRACTICE OF LUBRICATION FOR ENGINEERS. By Dudley D. Fuller. 1956, John Wiley and Sons, New York, N. Y. 432 p., $5^3/_4 \times 9^1/_4$ in., bound. $10.50. In the first half of this book, fundamentals of viscosity and flow are dealt with, and the hydrodynamic and hydrostatic theories are developed from simple and readily understood principles. In the last half, two chapters are devoted to journal bearings, and single chapters to typical industrial bearings, materials, air-lubricated bearings, dry friction, and boundary friction. Many bearing designs are given, including those for machine tools, generators, rolling mills, and centrifuges. The book is intended both for classroom use and for practicing engineers.

THERMAL POWER FROM NUCLEAR REACTIONS. By A. S. Thompson and O. E. Rodgers. John Wiley and Sons, Inc., New York, N. Y., 1956. 229 p., $9 \times 5^3/_4$ in., bound. $7.25. A discussion from the mechanical engineer's viewpoint of the engineering-design problems involved in the generation of heat in reactors, removal of heat from reactors, and the use of the heat in thermal power plants. Considerable space is devoted to calculations of neutron distribution, criticality, and reactor kinetics; problems of shielding, materials, thermal stress, and heat transfer are treated. The use of numerical methods and dimensional analysis for the solution of design problems is emphasized.

THERMODYNAMICS AND STATISTICAL MECHANICS. (Lectures on Theoretical Physics, volume 5). By Arnold Sommerfeld, 1956, Academic Press Inc., Publishers, New York, N. Y. 401 p., $5^7/_8 \times 9^1/_4$ in., bound. $7. The first chapter of the fifth volume of this treatise deals with such general considerations in thermodynamics as the first and second laws, thermodynamic equilibria, the van der Waals equation, and Nernst's third law. The second chapter, devoted to applications of thermodynamics to special systems, discusses gaseous mixtures, the theory of phase equilibria, blackbody radiation, and other topics. Chapters three and five deal with the elementary and exact kinetic theory of gases, and the fourth chapter is a consideration of statistical mechanics based on Boltzmann's combinatorial method.

# ASME News

## With Notes on Society Activities and Events

E. S. Newman, *News Editor*

**Large group of visitors inspect Canadair, Ltd., in conjunction with the 70th annual general and professional meeting of The Engineering Institute of Canada held in association with The American Society of Mechanical Engineers and American Rocket Society in Montreal, May 23–25, 1956**

# J. W. Barker Stresses International Co-Operation Among Engineers at EIC-ASME Meeting in Montreal

## EIC 70th annual meeting presented in association with ASME and ARS. EIC Confers Honorary Membership on ASME Secretary C. E. Davies

"Gatherings like this are a vivid example of our cordial and friendly relationship," said J. W. Barker, ASME President, at the ASME Luncheon held in conjunction with the seventieth annual general and professional meeting of The Engineering Institute of Canada. The meeting was held May 23–25, 1956, at the Sheraton-Mount Royal Hotel, Montreal, Que., Canada, in association with The American Society of Mechanical Engineers and American Rocket Society, an affiliate of ASME.

With the idea of stimulating still further international co-operation among engineers, Mr. Barker cited a few specific actions ASME and groups of Canadian engineers have already taken together; namely, ABC unified screw thread, ASME Boiler Code has been incorporated into law in eight Canadian Provinces, ASME's international program on research in the properties of steam.

"The relations between the ASME and The Engineering Institute of Canada have been fortunately happy," said Dr. Barker and cited the "barrier-less" manner in which men and ideas have been exchanged throughout the years and expressed the "hope it will continue to be even more fruitful. There is no product that we export so willingly or import so profitably, as the skill of the engineer and the knowledge of the scientist."

"We work," he concluded, "side by side under that wonderful motto—graven into stone many long years ago over the door of the British Institution of Civil Engineers, that 'Engineering is the Art of employing the great sources of power in Nature for the Use and Convenience of Mankind'."

Nearly 1700 delegates and visitors registered for the meeting. The record attendance was made up of members of the three societies and representatives of engineering institutions in Britain and France.

### New EIC Officers Announced

The newly elected officers of the Institute who were introduced at the meeting are: V. A. McKillop, president; H. R. Sills, G. M. Dick, and H. W. L. Doane, vice-presidents; and 21 councillors.

### Professional Meeting

The professional meeting got under way with the first of a fine program of technical papers, which continued through the next two days. In all there were 31 technical papers and three panel discussions covering a wide range of interesting and timely subjects. (Some of the papers have already appeared in the *Engineering Journal;* the remainder will be published in later issues.)

### Notes and Quotes From Technical Papers

"It is not generally realized even today that the major share of the seaway work is being carried out in the Canadian section of the river. In fact the project now under construction differs from the so-called 'all Canadian Seaway' only near Cornwall, where two locks and connecting canals on the American side have replaced similar structures proposed to be built in Canada," stated D. M. Ripley, senior assistant engineer, hydraulics, St. Lawrence Seaway Authority.

"River models are playing a large and indispensable part in planning and design for the St. Lawrence Seaway Project," said Dr. Duncan McIntyre, senior assistant engineer, hydraulics, St. Lawrence Seaway Authority. "Models have proven to be efficient tools for solving complex design and construction problems," he continued, "and have made a notable contribution to the development of an integrated plan of river development which is in the best interests of both power and navigation.

"The important problem now facing Canada's electrical-power-producing industry is to keep pace with prospective future power growth. Another problem is to attract and train engineers and other personnel capable of administering, planning, and operating the extensive power systems of the future," according to W. R. Way, vice-president and chief engineer, Shawinigan Water and Power Company, Limited, Montreal.

"The British Electrical and Allied Industries Research Association, commonly known as ERA, served primarily the electrical industry. The type of research concerned is that for which industrial reward would not justify individual action, and must therefore be pursued collectively, together with that which in any case must be applied collectively," stated Jerzy Miedzinski, development engineer, Department of National Defense, Navy, Ottawa.

"Specialized research organizations are responsible for most of the work," he explained. "There are 40 such associations, half of them with over 30 years of experience. They are maintained by the industry, with the help of government grants."

"The ERA research program is mainly concerned with initial examinations of new concepts on one side, with marginal improvements of established techniques on the other side, and with testing, standardization, coordination of effort, and so on" the speaker continued. Sixteen associations concerned with the engineering and fringe industries have between them a present income of some £2,500,000 of which four-fifths is subscribed by members of the various industries and the balance is a government grant. Income of individual research organizations ranges between £15,000 and £500,000. In addition, the engineering industry in Britain has recourse to some eight goverment research laboratories.

Three leading authorities from Britain, the United States, and Canada discussed air pollution: S. G. G. Wilkinson, of the Ministry of Housing and Local Government, London, England, whose subject was air pollution in Britain; Dr. E. A. Allcut, head, Department of Mechanical Engineering, University of Toronto, who spoke about pollution-control problems in Canada; and L. C. McCabe, president, Resources Research, Inc., of Washington, D. C., who dealt with current developments in air pollution in the United States. (Mr. McCabe's paper was not available at press time.)

"Britain's annual bill year after year in terms of money alone reaches the staggering total of £250 million; this figure stands comparison with figures obtained elsewhere: the estimate for Pittsburgh, in 1952, for example, produced a figure equivalent to over $55 for each inhabitant, whereas our £250 million represents over $14 per head over the population of the country as a whole." This was the most important feature of the Beaver Committee's Report at the end of 1954 on the damage done by air pollution, according to S. G. G. Wilkinson. This Report, the outcome of the 4000 deaths in December, 1952, from the same smog which covered London for four and a half days, showed beyond doubt that pollution is a dangerous enemy to human health.

The government had lost no time in implementing the Committee's recommendations, he said. The Clean Air Bill is now on its way through Parliament and may have become law by now. It repeals almost all present legislation about smoke pollution and substitutes a single new code, the main features of which are:

(1) The discharge of dark smoke from any chimney is prohibited, subject to limited exceptions such as the lighting up of furnaces from cold. The prohibition applies also to locomotives and ships.

(2) Any practicable means available must be used to minimize the release of grit or dust from furnaces. New furnaces must be equipped with apparatus to arrest grit or dust.

(3) The foregoing provisions, which mainly affect industry, will operate over the whole country. Enforcement is the responsibility of local authorities.

(4) Smoke from other sources, including domestic smoke, is dealt with on a local, and in a sense, voluntary basis. Local authorities will establish "smoke" control areas, in which smoke emission from buildings is prohibited. Householders will be entitled to grants for replacing their appliances, where necessary, to enable smokeless fuel to be burnt.

(5) Present arrangements regarding control of pollution from special processes by the Alkali Inspectorate are not disturbed. Supplementary provisions deal with new furnace design, smoke-density meters, height of new chimneys, and and pollution from colliery spoilbanks.

The Report had shown that domestic fires were responsible for nearly half the smoke in the atmosphere, added the speaker. It would have to be tackled if advances were to be made toward cleaner air. Yet the open fire is still a cherished feature of millions of British homes. Supplies of domestic smokeless fuels are very limited. The main substitute must be coke. Most grates are not constructed to burn coke; these must be replaced. So the abolition of smoke will not be a quick or simple process. The Committee had envisioned a long-term program of 10 to 15 years to deal with large urban areas alone, he said.

Recalling that since the beginning of this century the problem had increased in seriousness and complexity, Dr. Allcut pointed out its very name had been changed from "smoke abatement" to "air-pollution control." This had become a problem affecting whole communities and extending beyond the scope of purely short-term remedies or legislation. Lack of agreement on definitions and on techniques of measurement and control had led to an unsatisfactory situation that could only be rectified by agreement on an international basis. "Action to achieve this," he warned, "must be taken before it is too late."

"It should be remembered that the type of land and the meteorology of the country surrounding the industrial area, as well as heights of the industrial stacks, determine what air pollutants reach ground level in business and residential districts," he stated. "Moreover, a heavy layer of smoke haze at the ground, particularly if thickened by fog into a 'smog', resists the penetration of sunlight, thus pre-

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**G. R. Lord, chairman, ASME Ontario Section, who was chairman at the ASME-EIC luncheon meeting at the Sheraton-Mount Royal Hotel, Montreal, on May 25, introduces ASME President J. W. Barker**

**Sir George H. Nelson, *left,* President of the British Institution of Electrical Engineers; R. E. Heartz, *center,* EIC President, 1955–1956; and ASME President J. W. Barker, shown at the EIC President's Dinner in the University Club, Montreal, Que., Can.**

# C. E. Davies Becomes Honorary Member of EIC at 70th Annual Meeting in Montreal

At the annual banquet of The Engineering Institute of Canada C. E. Davies, secretary ASME, was awarded Honorary Membership in the Institute. In presenting the certificate the following citation was read:

Dr. Clarence Ebenezer Davies was born in Utica, N. Y., and graduated from the Rensselaer Polytechnic Institute with the degree of Mechanical Engineer in 1914.

Following graduation he entered the production department of the Smith Premier Works of the Remington Typewriter Company in Syracuse, N. Y. In 1917 he became an assistant production superintendent at the Frankford Arsenal of the United States Army and a year later was promoted to superintendent of its fuse shop. At the conclusion of the first world war Dr. Davies returned to the Remington Typewriter Company and shortly after became production superintendent at their Syracuse Works.

In 1920 he joined the staff of The American Society of Mechanical Engineers as associate editor. He has remained with that great organization ever since and has been its executive officer since 1931.

When the United States entered the second world war, he was called to the post of Chief of the Control Division in the Office of the Chief of Ordnance of the War Department in Washington, with the rank of Colonel. For his services in this connection he was awarded the United States Legion of Merit.

Colonel Davies was one of the organizers and the first secretary of the Engineers' Council for Professional Development, of which our own Colonel L. F. Grant has been president for the past three years. He is also secretary and treasurer of the Hoover Medal and Gantt Medal Boards of Award. For two years he was president of the Newcomen Society of England. He was also a member of the Council of the Society for the Promotion of Engineering Education from 1934 to 1937.

He joined the *Engineering Institute of Canada* as a member in 1937, and is, as well, a Fellow of his own Society and of the American Association for the Advancement of Science, a member of The Institution of Mechanical Engineers, of the Society of Automotive Engineers, of the American Management Association, and of a number of other organizations.

Colonel Davies was awarded honorary Doctor of Engineering degrees by Clarkson Institute of Technology in 1948 and by Drexel Institute of Technology in 1950.

Probably no other American engineer in our generation has done more than has Colonel Davies to promote mutual understanding and practical working relationships among the engineering societies of the Western World, and particularly between The Engineering Institute of Canada and The American Society of Mechanical Engineers. To this end he is constantly promoting the Institute's co-operation in important events and in the work of ASME technical committees.

It is fortunate for the profession that Colonel Davies found his place in institutional service. He has had a great influence in developing the engineering and scientific societies of his own country and their good relationships with similar organizations in many parts of the world.

The characteristics that have made Clarence Davies a great secretary and a great servant of our profession are imagination, vision, perception, dynamic and persuasive leadership, and his ability to plan and carry out great projects. He is a great secretary, a great engineer, and a great man.

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(*Continued from page 667*)

venting the heating of cold air in a valley which would make it rise."

Rapidly increasing use of mechanical transport adds to the problem. Gasoline engines on rich mixture give off large volumes of carbon monoxide, a very dangerous gas in sufficient concentrations, he continued. Harmful pollution from this source, however, seldom reaches dangerous levels. The problem of contamination from locomotives and steamships is not that of identification but rather that of jurisdiction, the speaker continued. Perhaps most of the local air-pollution-control procedures have been built around existing organizations originally designed for handling only smoke abatement.

A report by the Committee on Atmospheric Pollution in Canada, appointed in 1948, stated: "It is strongly recommended that the problem should be dealt with on a regional basis, by means of appropriate control areas set up by various provincial governments, as only these have the power to take such action. The fundamental principle for reducing smoke or other pollutants is quite simple," he observed. "Keep it from getting into the air!"

In conclusion, Dr. Allcut advocated the following principles which may usefully be observed in adopting a policy:

(1) Complete elimination of pollution is not economically attainable.

(2) The legislation must be enforceable and have community support.

(3) The enforcement policy must be one of continual adjustment and education.

(4) Except in cases of definite hazard to health or safety, plants must not be closed.

(5) The program must be "long-range." Results must not be expected too soon. Each community poses a new and different problem which can only be solved by arduous and persistent effort.

To complete a successful opening day of the professional meeting, there was a particularly enjoyable gesture by the City of Montreal in the form of a buffet supper at the Chalet on Mount Royal. His Worship, Mayor Jean Drapeau, welcomed a large gathering of delegates and guests, who spent a delightful evening overlooking the welcoming city and even a part of the St. Lawrence Seaway development that had been discussed that same afternoon.

**C. E. Davies, secretary ASME, receiving the certificate of his honorary membership in The Engineering Institute of Canada from R. E. Heartz, President of the Institute. The presentation was made at the annual banquet of the EIC in Montreal on May 25. The annual meeting and banquet of the Institute were the largest in 70 years of the organization.**

**Section of head table at the ASME luncheon held during the EIC annual meeting shows, *left to right,* EIC President R. E. Heartz, M. D. Hooven, AIEE President, Dr. L. M. Gilbreth and A. G. Christie**

### Canadair Trip

On the following day, Thursday, the afternoon was devoted to a most interesting visit to the Cartiervill plant of Canadair, Ltd., where members and other visitors were shown many of the latest developments and techniques involved in Canada's air-defense program. The developments went beyond the phases of design and production—far and fast, too, in the form of an exhilarating air display put on by Canadair and elements of Air Defense Command of the Royal Canadian Air Force.

The conclusion of this visit and air show was by no means the end of the day's activities. The annual dinner of the Association of Consulting Engineers of Canada, at which the chairman was J. G. Chenevert, was well attended by many members and friends who were addressed by Sir George H. Nelson, president of The Institution of Electrical Engineers.

On Friday a luncheon was held under the auspices of ASME, at which the chairman was G. Ross Lord, chairman of the Ontario Section of ASME. Those who attended heard a vigorous address by ASME President, Dr. J. W. Barker, on international co-operation among engineers.

### The President's Dinner

On the evening of May 22 the annual president's dinner was held and was a notable gathering of past-president and other officers of the Institute together with such distinguished visitors as President Sir George H. Nelson and General Secretary K. Brasher of The Institution of Electrical Engineers, and Joseph W. Barker, ASME President, with C. E. Davies, secretary of ASME.

R. E. Heartz, president of the Institute, paid particular tribute to the deans of engineering who were attending the special conference on engineering education. Every degree-granting Canadian university was represented at the dinner by its dean of engineering, except for one who was unavoidably absent because of convocation ceremonies.

The concluding event of the meeting was the banquet on Friday, followed by the reception and dance. The winners of awards and medals were received with enthusiasm and the guest speaker, Dr. David L. Thomson of McGill University, made a vivid and favorable impression on his audience with his discourse on engineering education from a university viewpoint.

### The Seaway Tours

Though the events of Friday evening formed the grand finale of a memorable annual meeting there were many who took advantage of the arrangements made on the following day, May 26, to visit the main works of the St. Lawrence Seaway development. Two tours were offered, one covering the developments in the Montreal area, and the other taking in the extensive projects near Cornwall and Iroquois, Ont., and Massena, N. Y.

(We could not conclude this report without expressing gratitude to the Editorial Staff of The Engineering Institute of Canada for the substance of the foregoing account of this meeting.—News Editor.)

## The Roundup

With this issue of Mechanical Engineering, on page 682 through 690, we introduce a new section. Entitled, "Roundup," it will be devoted to current engineering events, news, and comment of general interest. The Roundup this month includes stories of the VDI meeting in Berlin, the Niagara Falls disaster, how industry can stimulate interest in technical-society work, the ASEE Middle Atlantic Section Meeting, and the Atoms in Business Conference in Texas.

# Successful ASME Meetings Depend on Papers "In Hand"

Constantly on the alert to give even better service to its members and the profession as a whole, the Meetings Committee of The American Society of Mechanical Engineers has "inspected the machinery" that makes for a successful meeting. It was agreed that having technical papers "in hand" was of the utmost importance.

The Meetings Committee, within whose frame of operation the national meetings and division conferences are planned, unanimously agreed that the August 1 deadline for the receipt of recommended papers for the 1956 ASME Annual Meeting will be strictly enforced.

Jess H. Davis, chairman, Meetings Committee, in a letter to chairmen of divisions and committees participating in the Annual Meeting, pointed out that this step was necessary "since more than fifty per cent of the papers scheduled for general Society meetings have been listed in advance programs as being unavailable."

Papers available in advance of a meeting provide wider dissemination of technical information, and livelier and better discussion is the result. Prepared discussions of papers are automatically ruled out if copies are not available in advance of the meeting. Dr. Davis stated, "Often, these prepared discussions prove to be more valuable to the technology than the paper itself. Then too, by having pamphlet copies available in advance, the sponsoring agency can be reasonably assured of what each of its authors will say."

Does August 1 seem to be an early deadline for an Annual Meeting paper? The processing, styling, and printing of more than 300 papers proposed for the 1956 Annual Meeting is an involved and time-consuming process.

Furthermore, these more than 300 papers will have to be co-ordinated in a technical meeting of 125 sessions—obviously the best way to do the job is with papers in hand.

## ASME Coming Events

**Sept. 10–12**
ASME Fall Meeting, Cosmopolitan Hotel, Denver, Colo.
*(Final date for submitting papers was May 1, 1956)*

**Sept. 17–21**
ASME Instruments and Regulators Division and Instrument Society of American Exhibit and Joint Conference, Coliseum, New York, N. Y.
*(Final date for submitting papers was May 1, 1956)*

**Sept. 23–26**
ASME Petroleum-Mechanical Engineering Conference, Conrad Hilton Hotel, Dallas, Texas
*(Final date for submitting papers was May 1, 1956)*

**Oct. 8–10**
ASME-ASLE Third Lubrication Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.
*(Final date for submitting papers was June 1, 1956)*

**Oct. 24–25**
ASME-AIME Joint Fuels Conference, Sheraton Park Hotel, Washington, D. C.
*(Final date for submitting papers was June 1, 1956*

**Nov. 25–30**
ASME Annual Meeting, Hotel Statler, New York, N. Y.
*(Final date for submitting papers was July 1, 1956)*
*(For Meetings of Other Societies, see page 684)*

European welding operations reported at opening session of AWS-ASME meeting. Panel, *left to right,* includes S. A. Greenberg; R. W. Clark; C. P. Sander, chairman; and C. E. Jackson.

# ASME Sponsors Some Sessions at AWS Annual Meeting in Buffalo

## Record registration for technical program and welding show; report on European welding operations

REPORTS on new welding methods and papers describing the fabrication of nuclear-reactor components were some of the high lights of the American Welding Society's national spring meeting at the Hotel Statler in Buffalo, N. Y., May 7–11. Over 1600 persons registered to attend the 21 technical sessions which were jointly sponsored by AWS and the Metals Engineering Division of The American Society of Mechanical Engineers.

The Fourth AWS Welding Show held in conjunction with the technical meetings in Memorial Auditorium, May 9–11, experienced a record registered attendance of over 8000 persons who witnessed the largest display of welding equipment and materials ever gathered under one roof. Clocked attendee entrance for the three days was over 12,000.

### Opening-Session Events

The opening session was marked by an outstanding address by Joseph H. Humberston, AWS President, John J. Chyle, AWS President-elect, and J. W. Barker, ASME President. Other features of this session were: Several members of AWS received the National Meritorious Certificate Award; Fred L. Plummer, past-president of AWS, conveyed the greetings of the Japan Welding Society; and a three-member team reported on European welding operations.

Technological developments in welding have come along so fast that industry is lagging far behind in applying the new methods, Mr. Humberstone pointed out in his welcoming address.

Mr. Chyle presented a constructive review and analysis of the various papers to be offered at the meeting and outlined their important contribution to our present knowledge in the field.

Industry, government, and education are losing engineers through death or retirement faster than they are being replaced by young men being graduated from engineering schools, Dr. Barker told the audience.

Dr. Barker pointed out that the prospect was bleak for the next three years as it takes at least four years to educate a young man or woman in engineering, and that even after that the outlook is not too encouraging. The Russians, he said, are training more engineers than we are "but they have a long way to go."

Pointing out that in one midwestern university, entering students failed to pass fifth-grade arithmetic tests, Dr. Barker called upon the engineers, "not only as engineers but as citizens," to take an active role in fostering good educational practices.

### European Operations Report

Three members of a team of internationally known welding experts toured 11 countries last year and reported that "American industry is too complacent and not sufficiently aware of progress being made in European countries." Clarence E. Jackson, manager of welding, Metals Research Laboratories, Linde Air Products Co., Niagara Falls, N. Y., made the report.

The two other members of the team, who made briefer reports, included R. W. Clark, manager of welding section, turbine division, General Electric Company, Schenectady, N. Y., and Simon A. Greenberg, the AWS technical secretary.

"Technologically, the European countries are our equal in most instances. Right now, European industry is not competing on a large scale with American companies because it is too busy meeting the needs of its own markets," Mr. Jackson said.

"However, unless American manufacturers keep abreast of developments in Europe, we shall soon lose whatever small advantage we have," he warned. "Right now, there is somewhat less mechanization in Europe, but that is due to the availability of manpower at lower wages. There can be no doubt, however, that European industry can mechanize its operations any time production demands warrant such installations."

The papers delivered at the session on nuclear reactors revealed the welding techniques developed to overcome a number of unusual problems and design requirements. Typical of these problems was the task of welding 7000 ft of zirconium. Also, the feasibility of using brazing alloys in the high-temperature "plumbing" systems, where sodium corrosion and high-temperature oxidation are major factors, was discussed.

A new method of welding using the energy of ultrasonic vibrations was described for the first time during another technical session. It was brought out that solid-state bonding has been achieved with both similar and dissimilar metals by the introduction of elastic vibratory energy into the metals in the area to be joined. The process is, at present, applicable in joining foil and thin sheet to either very thin or massive members.

Other new welding techniques, methods, and equipment described in papers during the five-day meeting included:

New methods of control of rectifier type DC power source designed for metal-arc gas-shielded welding.

A new method of fabricating and launching vehicular-tunnel tubes.

New concepts for control of resistance welding machines.

Iron-powder electrodes and their applications.

Newly developed filler wires for welding high-strength low-alloy aircraft steels by the inert-gas-shielded arc-welding processes.

New developments in tin-zinc alloys for soldering aluminum.

Tungsten-arc cutting of aluminum.

A new procedure for root-pass welding of stainless-steel pipe and plate using the inert-arc process.

Welding heavy sections of aluminum alloys 6061-O, 6061-T4, 6061-T6, 5154, and 5056.

A new method of applying rotating bands to projectiles by means of welded overlays.

A two-day welding conference on practical aspects of welding was conducted.

ASME President J. W. Barker addresses opening session of American Welding Society's annual meeting in Buffalo, N. Y. ASME sponsored some of the sessions at the meeting.

View of Design Engineering Show on opening day at Convention Hall, Philadelphia, Pa. The show was held concurrently with the Design Engineering Conference sponsored by the Machine Design Division of The American Society of Mechanical Engineers, May 14–17.

# ASME Design Engineering Conference and Show a Tremendous Success

## More than 13,000 view debut of Design Engineering Show; 1263 at Conference

CONVENTION HALL, Philadelphia, Pa., was the scene of the debut of a new industrial exposition held from May 14 through 17. The first industrial exposition for design engineers, with approximately 30,000 components, materials finishes, shapes and forms, fasteners, and other items which go into the making of end products, was held in conjunction with the Design Engineering Conference sponsored by the Machine Design Division of The American Society of Mechanical Engineers. The show, produced by Clapp & Poliak, Inc., New York, N. Y., was viewed by more than 13,000 persons.

### Technical Sessions

The nine technical papers of the conference were presented at four sessions. The discussions were designed to point out the need for attracting men to the field, training them, and making provision for rewarding them for outstanding achievement. Other topics discussed included cost reduction as an important element in design and selection of engineering materials, and the effect of the trend toward miniaturization.

### Value Analysis in Product Design

W. L. Healy, supervisor, Data Bureau, Philadelphia (Pa.) Works, and A. D. Bentley, specialist, Value Analysis Services Section, General Electric Company, Schenectady, N. Y., told of the company's program. The value-analysis program calls for a single specialist to analyze every factor of cost in a product so that it may be produced at the lowest possible price. It differs from most conventional practices in that a single man is charged with responsibility for the cost of a product.

"The theory of value analysis is the elimination of unnecessary cost while maintaining the continued quality of the product," Mr. Bentley explained.

Among many examples, he described how the company's disposal unit for home-garbage removal was reduced in price from $135 to $85. After three months' study of several hundred parts and materials, it was found possible to cut costs in half.

Another item, a fighter pilot's "joy stick" used in radar control to bring an enemy target into position, was reduced 80 per cent in cost, he said.

The company is going into a greatly expanded program of training its own personnel in value analysis and will train more this year than in the previous five years, according to Mr. Bentley. About 1500 persons in all levels of jobs in engineering, marketing, manufacturing, purchasing, and sales will receive this training.

### How to Get and Train Design Engineers

"If the average production worker's time were as loosely scheduled and used as are many designers, both the company's manufacturing program and competitive position would be in rough shape," Chester Linsky, Pennsylvania State University, declared.

"Study after study shows that design engineers are being used for routine jobs which technicians or draftsman could do," he said.

One of the major factors of waste, Professor Linsky said, is the failure to provide the engineer with an assurance that his talents are being utilized to best advantage.

"Every newspaper is crowded with employment lures," he pointed out. "Note that while they stress job benefits, their big bait is the promise of challenging and high-level assignments. Employment interviewers and personnel managers tell me that this approach pays off better than any other recruiting technique. It would seem then that this would provide some excellent clues to what an organization could do to keep their engineers productive and satisfied with their work assignments without having to look elsewhere for more promising opportunities."

### Westinghouse Graduate Program

A. A. Johnson, manager of engineering, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., stated that one of the major inducements this company offers engineering graduates is an opportunity to continue their graduate education. The company has arrangements with 15 universities for evening courses leading to master's degrees and doctorates.

The company pays half the tuition fee for each course successfully completed and pays the remaining half when a graduate degree is won. More than 7500 professional employees have participated in this program, he said. Over 300 have earned master's degrees and 17 have earned their doctorates through this program.

He explained that these and other training

programs have brought the company rich rewards in stability of employment among engineers. During the recently ended Westinghouse strike, he said, fewer engineers left the company than even during normal periods.

## More Selective Recruitment

Bernard J. Covner, Dunlap & Associates, Stamford, Conn., declared that recruitment of engineers can be more selective and more efficient, even in the tight labor market which now exists. He urged greater attention to individual characteristics, both as to the man and the job to which he is assigned.

Among factors to be taken into consideration, he said, are the man's grasp on economics and his social outlook. "An engineer with a lack of knowledge of economics may not bear in mind the budget he has to work with nor the market possibilities of the product he is designing."

In line with the analysis of the individual approach to an engineer's capabilities, Mr. Covner added, "A man doesn't necessarily have to have an engineering degree to perform ably in certain engineering positions."

## Recognition and Reward for Invention

Four-thousand employees of Westinghouse Electric Corporation have contributed invention ideas to the company in the past five years, William A. Steiger, manager of the company's patent department, revealed at the concluding session of the Design Engineering Conference.

Mr. Steiger attributed the large number of invention ideas to a company-incentive plan started five years ago with rewards ranging from $25 to $5000. About half the ideas submitted, he said, merit the initial $25 award and about 10 per cent a further $50 award, given for those worth a patent application. Publicity attendant on making the awards is an important factor, he pointed out.

Each of the past three years has resulted in a record number of invention disclosures to the company, with the total in 1955 two and one-half times that of 1954, he said.

## Design Engineering Show

The debut of this latest industrial show was such an evident success that the producers, Clapp & Poliak, Inc., immediately announced that the event would be held again next year. Contracts have been signed for the show to be held at the Coliseum in New York, N. Y., May 20–23, 1957.

The show had on display hundreds of new products, some still in the experimental stage, with the hope that the designers would incorporate them into models now on the planning boards.

E. I. du Pont de Nemours & Co., Wilmington, Del., introduced a number of synthetic fibers, some far from full development, which included synthetic-fiber paper and the newest fiber, "Teflon," made of tetrafluoroethylene. Possible uses of synthetic-fiber paper and nonwoven structures include rug backing, bookbinding, tracing paper, and punch cards. Among experimental laminations for which orlon and dacron are suggested are automobile parts, meat pallets, pipe, and electrical sheeting.

Camera windows maintaining high optical qualities under temperatures ranging up to 2000 F, encountered in wind-tunnel operations and ultrasonic missile work, were shown by Corning Glass Works, Corning, N. Y. They are said to be especially useful for observation of high-speed pressure patterns in wind tunnels.

Among other newsworthy exhibits were included an electronic balancer, said to be capable of handling any rotating body from 4 oz to 100 lb; a greasemaking machine; many preplated metals; a metal-stitching machine for dissimilar metals which cannot be welded; plastic bearings which make outboard motors virtually noiseless; a wide variety of fasteners; plastic coatings for muffin tins which need no greasing for industrial baking; a mechanical drafting desk designed, it is said, to take the draftsman off his stool and seat him at a desk; many automation components; and paper made of glass fibers.

## Just the Beginning

The Design Engineering Show differs from most industrial expositions in that products shown are not sold in small amounts for use in a plant. Rather they are products which are incorporated into end products. Thus sales made by exhibitors are limited only by the sales ultimately made to the consumer.

An official of one exhibiting company, one of the nation's largest companies, declared that designers who attended the show suggested at least a dozen new possible uses for his products of which the company was unaware. An official of another large company, showing materials still in the experimental stage, stated that scores of uses have been suggested for the new materials and that it has received a number of valuable ideas for the directions which the development of the product should take.

**Huge crowd listens to the panel discussion on how to get and train design engineers during the ASME Design Engineering Conference held at the Philadelphia Convention Hall, May 14–17, 1956**

## People

NIKOLA TESLA, whose 100th birthday will be celebrated by engineers throughout the world on July 10, 1956, was a genius in many fields of scientific endeavor. He conceived the polyphase a-c motor and a suitable system of generation and distribution for applying it in the 1880's. The Niagara Falls disaster on June 7, 1956, resulting from rockfalls, recalls the impact the polyphase a-c system has had on power generation for the past 60 years (see page 685 of this issue). Tesla's inventions and researches have had bearing on radio, radar, neon and fluorescent lighting, and broadcasting, to mention just a few. He died in New York City in 1943. During the Society of Business Magazine Editors' Washington (D. C.) meeting, on June 7, 1956, a reception was held at the Embassy of Yugoslavia in honor of Nikola Tesla, the Yugoslavian who invented the induction motor and devised the polyphase system of electric current.

***Honors and Awards.*** DONALD W. DOUGLAS, president of the Douglas Aircraft Company, Inc., Santa Monica, Calif., has been chosen to receive the 1956 Elmer A. Sperry Award, "in recognition of his distinguished engineering contribution which has advanced the art of transportation through the development and production of the 'DC' series of airplanes." He will be presented with the award, which is sponsored by ASME, AIEE, and SAE, during the national aeronautic meeting of the Society of Automotive Engineers at Los Angeles, Calif., in October, 1956.

WALTER H. ZINN, noted scientist and Director of Argonne National Laboratory, was presented with a Special Commendation on May 16 by the U. S. Atomic Energy Commission. The presentation was made by Kenneth E. Fields, General Manager of the Commission, at a luncheon given in honor of the recipient by The University of Chicago. Dr. Zinn has been engaged in research and development work in the field of atomic energy for more than 17 years and has served as Argonne's director since July 1, 1946, when it was established as the successor to the wartime Metallurgical Laboratory of The University of Chicago. Among the many contributions to the nation's atomic-energy program by Dr. Zinn and his staff, the following are particularly noteworthy: The design and construction of the world's first heavy water moderated reactor; the development of the basic design of the first nuclear reactor for propulsion (USS *Nautilus*); the development of the basic design of the production facilities for the Commission's Savannah River Plant; the first production of electricity from nuclear energy; the first breeding of nuclear fuel; and the generation of electrical power by a boiling-reactor system and its subsequent use by the community of Arco, Idaho. Many of the reactors being designed and constructed by the electric-utility industry are based on pioneer development work performed by Dr. Zinn and his staff.

**See colorful Colorado from the air on a special ASME flight arranged for during the ASME Fall Meeting, Cosmopolitan Hotel, Denver, Colo., Sept. 10–12, 1956. Western Airlines will provide a one and one-half hour flight which will be available to members and their guests on Wednesday afternoon, September 12. The nonstop flight will leave Denver and fly to Colorado Springs circling such interesting spots as the U. S. Air Academy site, Pike's Peak, The Broadmoor, and others. From there to Canon City and the Royal Gorge, site of the world's highest suspension bridge. From there the flight will turn north up over Rocky Mountain National Park, Big Thompson Canyon, University of Colorado at Boulder, and back into Denver. This will be an amateur photographer's opportunity of a lifetime to record magnificent scenery.**

# More Effective Engineering Management Discussed at ASME West Coast Engineering Management Conference

THE first annual West Coast Engineering Management Conference of the Southern California Section Management Division of The American Society of Mechanical Engineers was held May 14 and 15, at the Hotel Statler, Los Angeles, Calif.

The technical program was carried out in four sessions; namely, Planning and control of complex engineering projects; intelligent use of engineering talent; enlarging the engineer's future; and current administrative trends. The 247 registrants were presented an array of distinguished papers which should provide considerable help in solving their many problems in engineering management.

In a discussion of the intelligent use of engineering talent, W. L. Collins, manager of organization and cost control for the Western Operating Division of the Standard Oil Company of California, concluded that the most urgent problem is to recognize the need "to use engineers on engineering work." This conclusion was preceded by comments on ten common management practices which tend to drive engineers out of engineering.

W. T. Powell, Mem. ASME, president, Emsco Manufacturing Company, Los Angeles, Calif., presented a set of five beliefs held by top management concerning unfavorable attitudes of engineers, and he said, "This is an important point because this belief is a fact whether or not the belief is true." This was followed by a complete discussion of four suggestions for engineers: (1) Like what you are doing, (2) know what you are doing, (3) work hard at it, and (4) be at the right place at the right time.

In a luncheon address on "The Engineer—Technician or Leader," W. L. Chadwick, Mem. ASME, vice-president—engineering, Southern California Edison Company, discussed and urged engineers to: (1) Be willing, interested, and anxious to spend as much time understanding people as machines, (2) enlarge the ability to see the whole of any problem, including the other fellow's viewpoint, (3) become expert in communicating ideas to other people, and (4) find ways to check results with other people as a form of feedback. He said, "If you are interested enough and become skilled enough in these four ways, you can indefinitely enlarge your future. Further, you can believe with assurance that you have moved from technician to leader."

V. A. Peterson, past vice-president, Region VII, ASME, and district manager, Elliott Company, Los Angeles, Calif., closed the conference by discussing three prime inherent qualifications for today's sales engineers: (1) Good health and a strong constitution; (2) honesty with himself, his employer, and his customer; and (3) genuine interest in other people.

Preprints of the papers were available only at the conference and no post-conference distribution is possible.

# ASME Regional Administrative Committees Held Meetings During March, April, and May

DURING March, April, and May of this year the eight Regional Administrative Committees of The American Society of Mechanical Engineers met to discuss, with the Vice-Presidents, various Regional and Society problems; to express Regional views on the National Agenda; and to provide representatives of Sections an opportunity to further the nominating procedure for national offices.

The present procedures have evolved from long experience with various methods of bringing representatives of the Sections together. Delegates from Sections first met at the 1915 Spring Meeting in Buffalo, N. Y.—two representatives coming from each of then 15 Sections.

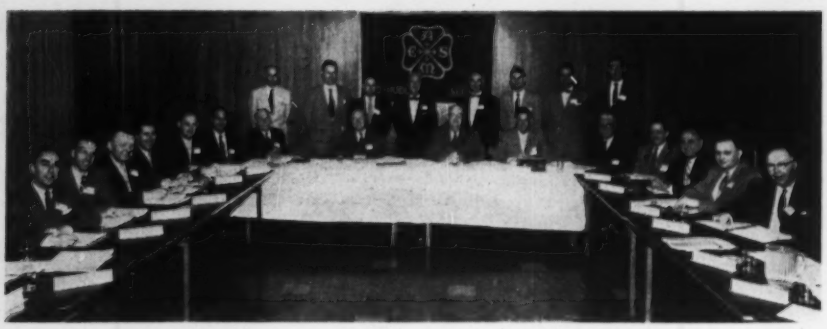
The Annual Conference started originally in 1916 and continued until 1931. The Sections had previously been grouped into seven groups for the purpose of selecting members of the Society Nominating Committee and in 1932 the Annual Conference was replaced by seven regional conferences using the same grouping used for Nominating Committee selection. A single delegate from each region attended a conference at the Annual Meeting. In 1935 the delegates from the regions were increased to two each, each serving overlapping terms of two years, and the Annual Conference was moved to the Semi-Annual Meeting.

In 1940 the number of regions was increased to eight. The following year the Vice-Presidents were assigned regional responsibilities and the present Regional Administrative Committees came into being, made up of two representatives of each Section. At the same time the Regional Delegates Conference was formalized.

The RAC meetings are held each year during March, April, or early May. The place is decided at the preceding RAC meeting or by the Vice-President. The date is arranged among the Vice-President, the Host Section, and the Secretary's office and confirmed at a meeting of Vice-Presidents.

Shown on these pages are six of the eight Regional Administrative Committees who met this year. A report on the 1956 Regional Delegates Conference, held during the ASME Semi-Annual Meeting in Cleveland, Ohio, June 17–18, at the Hotel Statler, will appear in a forthcoming issue of MECHANICAL ENGINEERING.

**Region I, Portsmouth, New Hampshire, May 4–5, 1956**



**Region II, Poughkeepsie, N. Y., April 30–May 1, 1956**

Region III, Wilmington, Del., March 22–23, 1956

Region V, Canton, Ohio, April 9–10, 1956

Region VII, Honolulu, T. H., April 20–21, 1956

Region VIII, Albuquerque, N. Mex., April 13–14, 1956

# Junior Forum

## Conducted for the National Junior Committee

By R. A. Cederberg,[1] Assoc. Mem. ASME

## Report From Canada

By Norman J. Viehmann[2]

### Professional Development Discussed by Panel at Junior Session of Joint EIC-ASME Meeting, Montreal, Canada, May 24

"WHAT can the young engineer do to develop professionally?" This question was tackled at the Montreal Meeting by four successful young engineers: Warren R. Thompson, power engineer, United Engineers and Constructors, Philadelphia, Pa., Vice-Chairman, National Junior Committee of the ASME; Guy Savard, Canada Liquid Air Company, Ltd., Montreal; Roger W. Honebrink, manager, Advanced Technical Programs, General Electric Company, Schenectady, N. Y.; and James F. Harris, consulting engineer, Toronto, Ont., Canada. The nearly one-hundred persons who attended the session were satisfied with the complete and meaningful recommendations given by these well-qualified gentlemen.

The panelists agreed that the graduating engineer should seek a job which will provide the best training and experience in the field that interests him most. He should then set an immediate goal for himself and prepare a program for self-development.

#### "Professional" Defined

To open the discussion Mr. Thompson described the professional as one who renders a specialized service based on advanced specialized knowledge and skill. This service is performed substantially in the public interest and in conformance with a distinctive code of ethics. He went on to say that the graduate just out of college should realize that he is equipped with a knowledge of fundamentals which he will have to learn to apply with understanding to engineering problems in the actual work situation. This new learning process constitutes most of his technical development.

To deserve claim to the title, Professional, requires more than technical competence. Three of the four speakers emphasized the need for developing personal attributes through participation in civic affairs, church work, activities of the professional society, and everyday social activities.

Mr. Honebrink mentioned the General Electric training program which after some 30 years of evolution now recognizes the need for developing in its engineering trainees: (1) an organized approach to engineering problems and (2) proper personal outlook and attitudes. The organized approach comprises six steps; recognize the problem, define the problem, seek methods of solution, evaluate the methods, select a method, and execute the solution. To satisfy the second need the following *engineering attitudes* should be developed; a positive outlook, an open mind, constructive discontent, and self-confidence in your own ability.

The importance of selecting a job that will provide the greatest opportunity for professional development was stressed by Mr. Savard. Many jobs now offered to graduating engineers lie mainly outside the engineering field. The speaker referred to many so-called sales-engineering positions. On the other hand, he said the formal engineering training programs provided by many companies afford unusual opportunity for professional development.

Without prior contact with one another, each speaker made this recommendation: Develop a planned program with set (but flexible) goals and work hard.

#### Planned Program

The planned program can be achieved after one has analyzed the requirements of his present job and of the next position to which he aspires with consideration given to his ultimate goals. Comparison of personal abilities and capabilities with job requirements will point the way toward a program of self-development. Such a program might include taking courses leading toward a master's degree, joining a public-speaking club, and so on.

Mr. Harris, a consulting engineer who is also a general manager and/or director of several young Canadian companies, suggests active participation in the work of the professional society. It is here that the young engineer has the opportunity to observe what goes on in other areas of the engineering world, to broaden his outlook, cultivate his professional attitudes, and to evaluate his personal goals.

Following a short discussion period, Co-Chairman Len MacLean introduced Colonel L. F. Grant, field secretary of The Engineering Institute of Canada. The Colonel described the Professional Development Program of the EIC. The Program has its own permanent staff which can be called upon by any Section to arrange for any course desired. Courses

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Junior Engineer, Jones and Lamson Machine Company, Springfield, Vt. Assoc. Mem. ASME.

**EIC-ASME Junior Session Panelists have informal discussion.** ***Left to right,*** **N. J. Viehmann, ASME co-chairman, Jones & Lamson Machine Company, Springfield, Vt.; J. F. Harris, EIC panelist, consulting engineer, Toronto, Ont., Can.; R. W. Honebrink, ASME panelist, manager, Advanced Technical Programs, General Electric Company, Schenectady, N. Y.; Guy Savard, EIC panelist, Canada Liquid Air Company, Ltd., Montreal, Que., Can.; W. R. Thompson, ASME panelist, power engineer, United Engineers & Constructors, Inc., Philadelphia, Pa., and vice-chairman, National Junior Committee; and G. L. MacLean, EIC co-chairman, sales engineer, Geocon, Ltd., Montreal, Que., Can.**

are currently being offered in ten cities in Canada. In one city a two-year program being offered leads to a master's degree. Colonel Grant expressed his satisfaction over the success of the program in aiding professional development among Canadian engineers.

Though the young engineer must begin with himself to develop professionally, he is at the same time provided with many well-planned industrial training programs, and the programs of professional societies and universities to assist him in his professional development.

## National Power Show Returns to New York Nov. 26–30

In the two months following the announced return of the National Power Show to New York, N. Y., after a four-year absence, nearly 200 leading companies have shown their keen interest by engaging exhibition space. Officially known as the 22nd National Exposition of Power and Mechanical Engineering, the display is scheduled for November 26–30 under the auspices of The American Society of Mechanical Engineers, in conjunction with the Society's 76th Annual Meeting. As heretofore, it will be under the management of the International Exposition Company.

Displays will feature the newest equipment in the vast power field and mechanical-engineering applications. An added attraction this year is an enlarged atomic-power section, including displays by many pioneering companies. Supporting these tangible evidences of progress in nuclear engineering will be the important technical sessions of the ASME Nuclear Engineering Division, as well as the National Industrial Conference Board's fifth annual "Atomic Energy in Industry" Conference, which will be held at the same time.

The exposition will be held in the recently completed New York Coliseum, most modern exposition hall in America, whose mid-city location is readily accessible by all means of transportation.

In naming this year's advisory committee, Irving E. Moultrop, who has long served as chairman, has been advanced to honorary chairman. Joseph Pope is the new chairman and John H. Lawrence is vice-chairman.

Other committee members include: Carlyle M. Ashley, president, ASRE; Chester R. Earle, executive editor, *Power Engineering;* M. J. Goglia, professor, school of mechanical engineering, Georgia Institute of Technology; John W. James, president, ASHAE; Kilshaw M. Irwin, vice-president in charge of engineering, Philadelphia Electric Company; C. E. Morrow, assistant superintendent, construction, Western Electric Company; George A. Orrok, Boston Edison Company; C. J. Sibler, chief engineer, West Virginia Pulp & Paper Company; A. Bowman Snavely, chief engineer, Hershey Chocolate Corporation; L. N. Rowley, editor, *Power*.

The following are representatives of the ASME on the committee: J. W. Barker, ASME President; Directors, Board on Technology—G. A. Hawkins, dean of engineering, Purdue University; Robert B. Lea, co-ordinator of exports, The Sperry Corporation; J. F. Downie Smith, dean of engineering, Iowa State College; G. B. Warren, General Electric Company, turbine department.

Also A. W. Thorson, chairman, Board on Technology; J. H. Davis, chairman, Meetings Committee; C. E. Davies, secretary, ASME.

The exposition is under the management of the International Exposition Company, 480 Lexington Avenue, New York 17, N. Y. E. K. Stevens, president, is manager of the exposition.

## NSF Funds for International Congress of Applied Mechanics

The National Science Foundation is planning to assist a limited number of engineers and scientists to attend the Ninth International Congress of Applied Mechanics in Brussels, Belgium, from Sept. 5–13, 1956. Applications for these international travel grants should be submitted to the National Science Foundation, Washington 25, D. C., not later than Aug. 1, 1956

# ASME Codes and Standards Workshop

### Standards Week

The last week of October has been traditionally Standards Week, during which time sectional committees and subcommittees sponsored by the Society under American Standards Association procedure concentrate meetings. The purpose of this has been to relieve the room shortage that inevitably appears at the ASME Annual Meeting.

October 29 to November 2 will be 1956 Standards Week. Committee chairmen will be queried shortly for their preferences as to meetings.

### Recent Revisions In Fine-Pitch Gear Standards Meet Needs of Industry

**By Louis D. Martin, gear consultant, Rochester, N. Y., Secretary Sectional Committee B-6**

American Standards are subject to frequent revisions in order to keep them abreast of the developments in the art. Every few years, every American Standard should either be reaffirmed or revised by its sponsors.

Sectional Committee B-6, on Gears, is jointly sponsored by the American Gear Manufacturers Association and by The American Society of Mechanical Engineers. It is the responsibility of these two organizations to see to it that gear standards are reviewed and kept up to date.

Among the standards recently reaffirmed or revised is a group of four fine-pitch gearing standards. In 1954 these standards came up for review. It was decided by the sponsors to reaffirm the standard for Fine-Pitch Straight Bevel Gears, AGMA 206.03, ASA B6.8-1950. This standard, in its present form, adequately meets the requirements of current fine-pitch straight bevel gear practices.

Three other standards were revised. Among these three was 20-Deg Involute Fine-Pitch System for Spur and Helical Gears, AGMA 207.04, ASA B6.7-1956. The revisions to this standard consisted of simplification of several examples, the elimination of minor typographical errors, and the addition of a format for putting gear dimensions on drawings in a logical, consistent manner, agreeing with AGMA and ASA gear nomenclature and established gear practices.

The format idea has been under development for several years and one for each type of gear is contemplated.

It was considered advisable to develop and process the formats through the standards "mill," separately rather than to wait until one for each type of gear had been developed. This permits the immediate use of a greatly needed guide. As each of the other formats is developed by the sponsors, it is contemplated that they will be added as an appendix to existing standards. It is also felt that eventually a separate gear-format package, covering all types of gears, may be developed as a separate standard.

Another fine-pitch standard recently revised is titled Design of Fine-Pitch Wormgearing, AGMA 374.03, ASA B6.9-1956. Most of the revisions on this standard were of an editorial nature. Among the major improvements is the adoption of a nonthroated, simplified, gear blank. This type of blank is suited to wormgears of fine pitch which are generally not highly stressed. A separate section covering blanks is also included in the revised standard.

The wormgearing standard is unique in including tables giving the change in profile shape and pressure angle which occurs when using a double conical wheel or cutter for forming the tooth profiles. The original development of these tables entailed a considerable amount of computation and work. Because the standard covers a finite pitch range, it was possible to develop a practical and useful guide. For those not versed in the many ramifications of wormgearing production it will be of interest to know that a single computation for profile-deviation and

pressure-angle change may take two to three days and involves the use of higher mathematics.

It was with the purpose of eliminating this cumbersome, time-consuming job that the tables were developed. During the five years of usage, they have proved useful in the gearing as well as screw-thread field.

Explaining the meaning of profile deviation in simple terms that can be grasped by the average gear man posed a problem. Many gear people, it was discovered, did not have a clear concept of exactly what was meant by profile deviations and what could be done about it. The value of the tables, therefore, was not fully appreciated.

An appendix was added to this standard, giving a simple graphic explanation of profile deviation with sufficient references for the inquisitive student who wants to find out for himself what is involved in the way of computations.

Inspection of Fine-Pitch Gears, AGMA 236.04, ASA B6.11-1956, received a critical review and considerably more attention than other fine-pitch standards. As a result, this standard is a great deal better and should receive greater use than the original version. This standard, which includes ten sections, was originally developed section by section by the American Gear Manufacturers Association. Due to the urgency of guides for quality control of fine-pitch gears used in the war effort, each section was released as developed. When all the ten sections were finally developed and assembled together, they were submitted by the sponsors to the American Standards Association.

In spite of a thorough editing job at the time, certain ambiguities crept in which were a perpetuation of old-fashioned ideas and innocuous redundance. For example, backlash was confused with tooth-thickness reduction as applied to a single gear. We know, by definition, that backlash is the play between engaging gear teeth and that a *single* gear cannot be said to have backlash until it is meshed with a mating gear. Nevertheless, the section on backlash was ambiguous in this regard.

It must be remembered that standards reflect the composite thinking of many schools of thought, and are the best compromise that can be effected in the thinking of diverse individuals of a given era. They should be accepted as foundations to build on, rather than finished, unchangeable documents. As time passes, and new ideas are developed, the thinking changes. It was even so with this standard. Today we are willing to accept principles and ideas that were considered too drastic eight or ten years ago. The changes and improvements in this standard are

1 Elimination of ambiguities.

2 New section on backlash.

3 Addition of tables by means of which it is possible to set limits of variable-center-distance fixture for any combination of tooth reduction and composite error within the scope of the standard.

4 The inclusion of latest rack and similar checking devices.

5 An appendix explaining the use of the table mentioned in item 3 and the essential differences between checking by means of a rack and circular master gear.

The major part of the revisions was undertaken by the Fine-Pitch Gearing Committee of the AGMA, and the ASA Subcommittee on Fine-Pitch Gearing under Sectional Committee B6. The personnel of these two committees and their able chairmen should feel gratified by a job well done.

## New Publications

B36—Sixteen revisions and 16 new standards for wrought-iron and wrought-steel pipe and tubing. Available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Supplemental 1955 Addenda to Unfired Pressure Vessels (1952 Edition).

# Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

| New York | Chicago | Detroit | San Francisco |
|---|---|---|---|
| 8 West 40th St. | 84 East Randolph St. | 100 Farnsworth Ave. | 57 Post St. |

## Men Available[1]

**Industrial Engineer,** BME, ME; 34; eight years' experience production, cost, and quality control; project engineering. Electromechanical manufacturer and transportation industries. Me-304.

**Mechanical Engineer,** 33, eight years' chemical-process industry experience in project, power and plant engineering, plant construction and alteration, equipment and building maintenance, instrumentation, heating and ventilation, equipment, and process improvement. Prefers position in Northeast with future. Me-305.

**Chief Industrial Engineer,** BSIE, registered PE, 33; nine years' broad experience in wage incentives, production standards, materials handling, layout, and cost reduction in light manufacturing and chemical industry. Seeks expanding company. Location open. Me-306.

**Plant Engineer,** BS(ME), 30; 1¾ years' maintenance engineering in oil refinery; two years project engineer in U. S. Army; 2½ years power and fuel engineer in steel mill; three years in U. S. Merchant Marine. Hold unlimited marine-steam engineer's license (1946); hold Chicago Station Engineer's license (1947). Desires Midwest, East, or West. Me-307-499-Chicago.

**Research and Development,** electromechanical, supervisory, or technical direction, strong in analysis, PhD in Mechanics, 31; ten years' teaching, research, and development, machine, electromechanical, pneumatic, etc., devices. Prefers Chicago but will relocate. Me-308.

**Product Manager,** mechanical engineer, executive and administrative experience; BSME, 38; manager of company department of control products—sales over $700,000. In charge of design, development, sales co-ordination, production, and service of precision-mechanical products. Opportunity important; prefers end products for industry. Will relocate. Me-309.

**Executive Engineer,** ScD, PE; ten years' experience in structures research, flutter, vibration, shock, and testing. Desires research-director position with medium-size company or assistant to "top level" engineering executive of large corporation. Me-310.

**Senior Engineer,** BS, 37; ten years' layout and design experience, mostly utilities, in large petrochemical plants. Will consider position with small firm at minimum salary with profit sharing or other plan. Desires West or Midwest. Me-311-Chicago.

[1] All men listed hold some form of ASME membership.

## Positions Available

**Engineers.** (*a*) Project engineer, preferably graduate mechanical, 27–40, experience in paper-converting machinery, for supervision of creative design and development projects for manufacturer of web coating, laminating, printing, and treating machinery. $6000–$8000 (*b*) Machine designer, experienced, preferably in paper, plastic, or textile-converting machinery. To $7000. N. J. W-2988.

**Personnel Director,** 35–45, engineering graduate, at least five years' personnel-management experience in drug, cosmetic, or allied process manufacturing fields. $12,000–$14,000. New York, N. Y. W-3310.

**Consultant,** metals - processing - development service in a manufacturing laboratory; 40–50, mechanical degree, at least ten years' experience in light forging, die casting, continuous casting, extrusion, wire processing or reinforced plastic dies and fixtures. $14,000-$16,000. Eastern N. Y. State. W-3316.

**Sales Engineer,** 26–60, mechanical graduate, three years' outside sales experience for metal-products manufacturer. Must have own car; some travel in northeast U. S. $5200, plus expenses. Headquarters, R. I. W-3317.

**Engineers.** (*a*) Designer, for automatic machinery, for materials handling and processing, degree in mechanical or equivalent, 30–50. Must be a lead man who can assume charge of a job; with ten to 15 years' industrial experience. $7200. (*b*) Senior engineer, graduate mechanical or chemical, 28–50, at least six years' experience, most of which has been in papermaking, preferably feltmaking such as roofing felt or flooring felt and should be familiar with paper-mill equipment and operations, possibly Kraft processing equipment; should be capable of making economic studies and of selecting the proper types of equipment to handle specific require-

ments in the paper field. $7800. N. J. W-3342.

**Engineers.** (*a*) Sales engineer, mechanical graduate, 35–45, experience in customer contact on precision-metal parts and special metal-processing machines. $8000–$10,000. (*b*) Production engineer to make recommendations for improvements in automatic metal-fabricating machinery, do plant layout and act as chief trouble shooter in plant. $7800–$8000. Northern N. J. W-3354.

**Production Engineering Manager,** 35–50, graduate mechanical, for company which processes, packages, and distributes a basic and widely used food product. Previous manufacturing and production-engineering experience, five years of which must have included experience in product management in a multiplant operation in a process industry. Will be responsible for the direction and co-ordination of all manufacturing and production engineering at all plants. Opportunity for promotion to vice-president of production. Salary open. Headquarters, Southwestern United States. W-3364.

**Machine Designer,** mechanical-engineering training and at least five years' heavy machinery or equipment experience for design and development of crushing, grinding, and pulverizing machinery. Company will pay placement fee and moving expense allowance. $7000–$8000. Ohio. W-3380.

**Teaching Personnel,** general engineering department, degrees in mechanical, electrical, civil, and industrial engineering. Positions available September, 1956. Rank and salary open. West. W-3387.

**Chief Engineer,** mechanical graduate, at least five years' design, specifications, and engineering supervision in the manufacture of metal tanks, containers, and installations of pumps and controls. $9000–$10,000. Queens, N. Y. W-3396.

**Recent Graduate Engineers,** mechanical, civil, electrical, mining, or metallurgical, for mining properties in South America. From $6000. Company will pay placement fee. Transportation and living quarters provided. Single status. South America. F-3407.

**Recent Graduate Engineers,** training program in natural gas industry. (*d*) Mechanical graduate to make power studies of long-transmission lines and compressor-station combinations, study town-distribution systems and regulation stations. $4800–$5100, to start. Ohio. W-3411(*d*).

**Manager of Employee Training,** under 42, mechanical degree, teaching and engineering experience in metal-products fabrication, to take charge of training within industry, job instruction training, development of visual and seminar methods, and improvement of industrial-education program. $14,000–$16,000. New York, N. Y. W-3413.

**Assistant Professor,** mechanical or industrial engineer, degree, to teach manufacturing processes and to be in responsible charge of all machine laboratories. Position available September, 1956. $6000 for nine-month period. East. W-3417.

**Plant Engineer,** to supervise the construction of a building, installation of conveyers, dryers, and other equipment, in planning a building extension of about 35,000 sq ft to fit a new system of final finishing hardwood plywood. Must be capable of handling improvements of all kinds and major maintenance jobs. South. W-3419.

**Paper-Mill Engineer,** preferably graduate, design, construction, and some operating experience of paper and pulp mills. Will do design engineering of paper and pulp mills including planning and supervision of work and co-ordination of engineering with construction. To $12,000. New York, N. Y. W-3435.

**Engineers.** (*a*) Machine designer, mechanical, five or more years' experience designing small automatic machinery. Should be able to develop machine from product or sketch and follow through on construction of working models. (*b*) Tool and die designers, with two to five years' actual die experience and job-shop design experience desirable, to design progressive dies from terminals or other small parts. To $8000 (*a* and *b*). (*c*) Quality-control engineer, graduate, experience in quality-control work and in administration of sampling techniques for the establishment of lot tolerances. $7000–$7200. W-3439.

**Equipment Inspector,** mechanical or chemical degree, 25–40, three to four years' experience in inspection of all types of oil-refinery processing equipment, such as heat exchangers, fired heaters, lines, fittings, pumps, etc. $6060–$8400. Company housing; liberal benefit plans and allowances; no income tax. Near East, with assignment from 24 to 30 months and approximately three to three and a half months home leave. F-3458.

**Engineers.** (*a*) Hydraulic engineer familiar with hydraulic turbine work, design and application. This experience essential. $8000–$9000. (*b*) Draftsman, mechanical, experience on hydraulic turbines. $6000–$6500. Company will pay placement fees. Midwest. W-3471.

**Engineers.** (*a*) Product engineer, 35–40, mechanical graduate, at least eight years' equipment design and manufacturing experience in light chemical or drug fields. $10,000–$12,000. (*b*) Design engineer, mechanical graduate, design and layout experience in process-manufacturing fields. $6000–$8000. N. J. W-3473.

**Engineers.** (*a*) Project engineer, mechanical degree, three to five years' experience, to do planning, co-ordinating, surveying, and designing efficient and special economical production machinery. To $8500. N. J. W-3480(*a*).

**Senior Industrial Engineer,** 30–45, industrial degree, at least five years' consulting or manufacturing experience in methods handling, plant layout, and management studies in metal-products fields. Considerable traveling. $8000–$15,000. Headquarters, New York, N. Y. W-3483.

**Plant Engineer,** 30–40, mechanical graduate, three to five years' supervisory experience, familiar with mechanical machinery, operating a machine shop, the making of tools and dies, and plastics, for a company manufacturing rubber, plastic, and braided-covered wire, metallic and non-metallic armored cable. $10,000, plus. New York metropolitan area. W-3487.

**Tool-Project Engineer,** mechanical graduate, five years' experience in project design and tooling on cutting tools and equipment for machining aircraft structures. $8600–$11,000. Long Island, N. Y. W-3491.

**Assistant to Plant Engineer,** 32–40, BS in mechanical engineering, capable of handling electrical and civil problems, with experience in materials handling in an operating plant. Open-pit mining experience helpful. Salary open. Jamaica, B.W.I. F-3497.

**Senior Engineer,** minimum of 11 years' experience, to take charge of mechanical and piping group on steel mills and heavy industry and experience in piping and some power; know solid, liquid, and gas materials handling; pressure vessels, etc., $8400–$9600. Pa. W-3503(*a*).

**Design Supervisor,** mechanical degree, design experience in job shops or manufacturing, qualified to handle a variety of projects and keep all of them under control and moving forward. Company will pay placement fee. $10,000. West Coast. W-3504.

**Engineers.** (*a*) Chief engineer, 35–45, engineering graduate, at least ten years' experience with extruded plastic, metal products, and wire drawing fields. $15,000–$20,000. (*b*) Production-planning supervisor, mechanical or industrial graduate, to be responsible for all phases of planning and processing plastic and metal-products manufacturing. $6500. New York metropolitan area. W-3519.

**Mechanical Engineer** for manufacturer of controllable pitch propellers and commercial vessels. Must have machinery-design experience and administrative capacity. Position will lead to that of chief engineer. Some knowledge of marine equipment or Kaplan water turbines helpful. $8000–$12,000, depending upon experience. New York, N. Y. W-3524.

**Research and Development Engineer,** graduate mechanical, to be responsible for product testing, product development, and new uses of products, as they are brought to life by chemists, research, and highly technical-type of engineers. Will consider recent graduate engineer and train for work. Salary open. First six months in New York metropolitan area and later in Westchester County, N. Y. W-3527(*a*).

**Plastics Engineers.** (*a*) Injection-molding engineer capable of product, mold, and fixture design and repair, complete estimating of cost through finishing. Must be able to run in and evaluate new molds and parts. (*b*) Injection-molding superintendent capable of supervising 20-machine operation, co-ordinating three shifts with foreman and engineering. Complete charge of labor relations, able to run in and evaluate new molds and parts. Salaries open. Chicago Ill. W-3530.

**Design Superintendent,** BS in mechanical or electrical engineering, 35–50, 15 years' experience in basic-metals industry; must have good administrative experience. Duties will include functional design in connection with fabrication and reduction equipment, methods of operation and processes; co-ordination of construction and operation, engineering activities effecting physical facilities and equipment during installation and start-up; co-ordinate and supervise a large engineering staff. Salary open. South. W-3533.

**Development Engineer,** graduate mechanical, for manufacturer of gages, valves, industrial, and electronic instruments, six to ten years' experience, particularly with small mechanisms in the fields of thermodynamics, hydraulics, steam, or pressure vessels, or strength of materials. Position will be in field of engineering development and responsibilities will include product design and redesign to meet new requirements. Salary open. Conn. W-3537.

**Design Engineer,** mechanical, 26–35, graduate mechanical engineer, four to five years' experience in product development, applications, or allied fields. Should be acquainted with metal-working, that is machining, fabrications, and welding. Will design and draw various applications of aluminum to satisfy customer requirements. Salary open. West Coast. W-3539.

**Chief Engineer, Pumps,** mechanical graduate or equivalent, 35–55, at least ten years in responsible design of centrifugal pumps. Knowledge of application of pumps. Will report directly to works manager and be responsible for a department of four or five engineers on design of single and double suction, nonclog type of pumping equipment. Should have some field experience in addition to design. $7500–$10,000. Employer will negotiate fee. Chicago, Ill. C-5032.

**Assistant Associate Editor,** mechanical graduate, to 35, proved ability in writing. Know power distribution. Will be required to write original articles based on field trips, edit contributed articles, cover newsworthy engineering events and meetings, 25 per cent travel; no car required. To $8500. Employer will pay fee. Mich. C-5045.

**Distribution Superintendent,** chemical engineer or mechanical, at least five years' experience in operating chemical plants. Will be in charge of several plants manufacturing carbon dioxide gas. $9000–$9500, plus profit sharing. Company will pay moving expenses and placement fee. One for East Coast and one for Midwest. C-5050.

**Refinery Superintendent,** chemical engineer, about six years in refinery processing. Know atmospheric-distillation unit, UOP catalytic crackers, and similar equipment. Will direct the activities of the various departments and units of the refinery in order to get the job done most effectively and efficiently. For a refiner of petroleum. $9600–$12,000, plus profit sharing Company will pay fee. West. C-5067.

**Junior Engineers,** petroleum, mechanical, civil, or physics, with at least two years in drilling or production operations in petroleum industry. Will train for drilling, refining, or production work in the petroleum industry. $5700–$6600. Company will pay moving expenses and placement fee. West. C-5068.

**Sales Engineer, Steel Abrasives,** 25–35, at least two years in sales of industrial equipment. Should know mechanical or metallurgical operations. Will sell and contact established accounts or new accounts for line of steel abrasives or blast equipment. Relocation into territory after factory training for several months. $5400–$6000, plus commission and expenses. Some travel; car furnished. Company will pay moving expenses and placement fee. Ind. C-5073.

**Manager of Manufacturing Engineering,** mechanical graduate, to 50, at least ten years in design processing and manufacturing controls, or similar devices. Know production equipment and operations. Will be responsible for entire tooling, processing, plant, and manufacturing-engineering activities. Will supervise a staff of 36–40 people. To $15,000. Employer will pay fee. Ind. C-5080.

**Design Engineer,** new product, BSc in ME, EM, MetE, ChE, EE, 27–50, minimum of five years' experience required in design and/or development with an aptitude for invention. Knowledge of standard manufacturing procedures as related to design problems. Duties will be: Responsible for development of basic and/or experimental ideas and designs into production

designs; analysis and interpretation of customer drawings and specifications; supervise layout men and detailers in completion of projects. Capable of performing simpler design calculations, but recognizing need of more complex-analysis where applicable. $5400–$6600. Employer may negotiate fee. Midwest. D-2999.

**Experimental Product Engineer,** 30–50, BSc in ME, EM, MetE, CE, minimum of five to ten years' experience required in design and/or development, with aptitude for basic-product development. Knowledge of design and development principles and evaluation. Duties: responsible for basic design of experimental product to meet defined requirements; determination of limitations, compromises, fulfillments of design requirements through media of calculations, drawings, reports, experimentation, and test; selection and specifications of materials for the product as established by the design. Advise and counsel product engineers during designing for production. $5700–$7200. Employer may negotiate fee. Midwest. D-3001.

# Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after July 25, 1956, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

## New Applications and •Transfers

### Alabama

EDMUNDSON, KENNETH A., Decatur
FARROW, STANLEY, Huntsville

### Arizona

•COCKLIN, HUBERT W., Tucson
LAMBERT, JOHN W., Phoenix

### Arkansas

REAMEY, HERBERT K., JR., Arkadelphia

### California

ALLISON, LLOYD H., Montebello
•BARISH, HERMAN B., Sherman Oaks
BLESSING, WILLIAM H., Palo Alto
CARTER, JOHN H., Glendale
CLINGWALD, RALPH A., Monterey Park
HEYES, GORDON E., Anaheim
HUME, JAMES P., Northridge
JACOBS, MARSHALL R., Los Angeles
KATZ, ELLIOTT L., San Diego
MEYERS, FRANK C., Los Angeles
MORRIS, EDWARD, Los Angeles
NACHBAR, WILLIAM, Van Nuys
PERLMUTTER, JOSEPH, La Mirada
REINTHALER, CHARLES R., Gardena
RUUD, ROBERT P., Downey
SOMMARSTROM, CLIFFORD E., Piedmont

### Colorado

JOY, WARREN W., Denver
VIERLING, WILLIAM H., Climax
WADDLE, CRAIG C., Grand Junction

### Connecticut

BUNDEGAARD, HOWARD, Rowayton
LARSON, JOHN W., Newington
LOCKARD, FRANK P., East Hartford
LUNDBERG, WAYNE R., Manchester
MCLAUGHLIN, ROBERT D., East Norwalk
SCHNEIDER, ROBERT W., West Hartford

### Florida

GOODWIN, AUBREY C., Pensacola
ROGERS, WALTER H., JR., Miami

### Georgia

SMITH, TALBERT E., JR., Atlanta

### Illinois

HEAD, THOMAS W., East Peoria
HOGLUND, FRANK W., Chicago
MESERVE, HUGH B., Villa Park
•MOLONEY, HAROLD E., Depue
ROSENBERG, GERALD S., West Peoria

### Indiana

SARGENT, ROBERT O., Munster

### Iowa

OSGOOD, BERTRAM H., Des Moines

•Transfer to Member or Affiliate.

### Kansas

•BATES, CLIFFORD A., Prairie Village
BOWER, ROBERT B., Overland Park
JONES, ROBERT C., Overland Park

### Kentucky

•EVANS, DAVID W., Louisville

### Louisiana

MCDERMON, WALTER, Shreveport

### Maryland

CERCY, ROMA C., Baltimore
CHAMPLIN, EVERETT E., Frederick
HAMPFLING, GERALD L., W. Hyattsville
KOERNER, HARRY E., Catonsville

### Massachusetts

BEAMAN, SAMUEL T., Fitchburg
HENRY, JOHN R., Framingham
JACOBS, STEPHEN, Fitchburg
MANN, JOHN W., JR., Essex
SEIFERT, WILLIAM W., Cambridge
SHANN, WILLIAM E., N. Chelmsford
•SHERMAN, ARTHUR F., Andover
VAN ALSTYNE, PAUL C., Brookline

### Michigan

LANE, RICHARD O., Munith

### Missouri

ARENDALL, JAMES B., Kansas City
•CLYMAN, HAROLD J., Kansas City

### New Jersey

BACHMAN, ROBERT B., West Orange
CARSON, ROBERT W., Little Falls
CLARK, ADRIAN N., Princeton
CYPHERS, KENNETH L., Cedar Grove
•GOULD, GLENN L., Dover
HEESE, WILLIAM E., Passaic
MULLER, FRED, JR., Florham Park
ROEHRIG, HERBERT W., Newark

### New York

AHERN, FRANK D., Great Neck
ALBIN, GERALD L., Elmont, L. I.
•ATHENS, ARTHUR S., Vestal
BILSKY, HERBERT W., Mt. Vernon
BYER, MARSHALL, Painted Post
•CATENARO, EMIL A., Rome
FRISCH, BERNARD E., Vestal
KEATING, THOMAS F., Olean
LAURI, JOHN P., Brooklyn
LUMING, MAX, Watertown
MASSEY, ALBERT G., Watertown
PLOUGH, HOWARD V., Wellsville
•PULITO, DOMINICK M., New York
ROACH, CHARLES J., Brooklyn
ROSENBAUM, KURT, Bayside
•RYAN, CLIFTON M., Rochester
SHEVACK, NOEL H., Rosedale
SUYEMATSU, KING, Johnson City
THOMPSON, GENE J., New York
ULBRICH, ERNEST H., New York

### North Carolina

WALKER, GRADY C., Charlotte

### Ohio

BENNETT, ROGER L., Cleveland Heights
JONES, GEORGE P., Shelby
KESSOCK, ANDREW, JR., Columbus
MANOR, PAUL A., Barberton
MCLELLAND, CHARLES D., Akron
MILLER, LAVON J., Toledo
•SAMPSON, MERRITT B., Chagrin Falls
•SMITH, GEORGE W., Columbus

### Oregon

VITAS, JOHN K., Portland
•WIEGAND, ROBERT E., Portland

### Pennsylvania

DEMPSEY, KENNETH B., Pittsburgh
GOOD, ANTHONY P., JR., Pittsburgh
HINDMAN, JOSEPH A. E., Abington
RUCKER, JEFFERSON D., Pittsburgh
SEELINGER, RICHARD W., Erie
STOICA, JOHN T., Erie

### Rhode Island

ANDERSON, GORDON F., Providence
FAIN, MITCHELL, Providence

### South Carolina

BRADY, EVERETT P., JR., Camden

### Tennessee

HARDISON, WAYNE B., Columbia

### Texas

•ARNALL, FRANKLIN M., Texas City
HAMILTON, JACK H., Dallas
MERKEL, WILLIAM K., San Antonio
SMITH, ROBERT W., Dallas
WEMPE, ALBERT L., Conroe
WEST, ROBERT F., Corpus Chirsti
WROTH, WILLIAM F., Lake Jackson

### Virginia

LEWIS, HARRY T., JR., Norfolk
THOMPSON, RALPH C., Burke

### Washington

CHILDS, MORRIS E., Seattle
CLAUDSON, THOMAS T., Richland
HARRISON, CHARLES W., Richland
KARNIS, ANTHONY J., Richland
LOVE, COY E., Richland
OLDRIGHT, WILLIAM E., Seattle
ZWEIG, ARNOLD, Hoquiam

### West Virginia

COSNER, ROBERT R., South Charleston
CRAWFORD, ROY M., South Charleston
HUGART, JORDAN S., St. Albans
POFFENBERGER, JOSEPHINE B., South Charleston
WALSER, JOHN F., Huntington

### Wisconsin

OPDYKE, RICHARD E., West Allis

### Foreign

BHOSH, PRIYA B., Derbyshire, England
BRAGANZA, J. V. P., Bombay, India
KENT, GEORGE S., Lanikai, T. H.
KIBRIA, GHULAM, Lahore, Pakistan
MENIRU, GODWIN U., Aba, Nigeria
NAKASHIMA, CLARENCE I., Honolulu, T. H.
NUMACHI, FUKUSABURO, Sendai, Japan
•QUAN, BEN, Ottawa, Ont., Can.
SARTORI, GIUSEPPE, Treviso, Italy
TUSIEWICZ, JERZY M., Toronto, Ont., Can.

*Transfers from Student Member to Associate Member* ..... 631

# Obituaries

**Wilfred Bancroft (1874–1955),** controller, Lanston Monotype Machine Co., Philadelphia, Pa., died Dec. 18, 1955. Born, Philadelphia, Pa., June 9, 1874. Parents, J. Sellers and Anne S. (Richardson) Bancroft. Education, BS(ME), Massachusetts Institute of Technology, 1897. Married Elizabeth Nields, 1905 (deceased). Mem. ASME, 1912. He had several inventions in connection with monotype, organized schools for teaching monotype operators, and devised an inspection service. Author of numerous technical papers. Survived by three children, John N., Aiken, S. C.; Gertrude, Washington, D. C.; and Wilfred, Jr., Wynnewood, Pa.

**John Ervin Bullard (1880–1956),** editor and free lance writer of technical and business papers, Cranston, R. I., died April 4, 1956. Born, Keene, N. H., May 10, 1880. Parents, Ervin M. and Luella Bullard. Education, PhB, Brown University, 1908. Married Annie K. Falconer, 1910.

Assoc-Mem. ASME, 1913. Author of articles for more than 400 publications, sometimes using the names of Robert Falconer and Elliott Church. Author of three books on merchandising. He was president of National Business Writers Association. Survived by wife, two daughters, a brother, three sisters, and four grandchildren.

**Ollison Craig (1888–1956),** vice-president, Riley Stoker Corp., died April 3, 1956, at Ft. Lauderdale, Fla. Born, Sullivan, Ill., Jan. 21, 1888. Parents, Francis Marion and Effie (Hampton) Craig. Education, BS(ME), University of Illinois, 1909; ME, 1920. Married Bertha Shelton, 1909. Mr. Craig was prominent in national engineering circles and had been associated with Riley Stoker Corp. since 1920. He held professorship in engineering at the University of Colorado, Vanderbilt University, University of Texas, and Iowa College. Fellow ASME, 1946. He was awarded the Society's special 75th Anniversary Medal May 12, 1955, for professional achievement and service to ASME. Throughout his long and active membership he continuously furthered the aims and objectives of ASME. He presented a number of technical papers before the Society. Survived by wife, a son, and four grandchildren.

**Jacques Gatspar (1894–1956),** of Sulzer Bros. Ltd., Zurich, Switzerland, died April 6, 1956. Born, Craiova, Rumania, April 2, 1894. Education, graduated from Technische Hochshule, Stuttgart, 1916. Mem. ASME, 1953. Author of a paper, "High Pressure Boilers" (paper No. 52—A-121), presented at 1953 ASME Annual Meeting. He was a member of the Swiss National Committee of World Power Conference.

**Daniel Cowan Jackling (1869–1956),** retired president and director of the Mesabi Iron Co., died March 13, 1956. Born, Hudson, Mo., Aug. 14, 1869. Parents, Daniel and Lydia Jane (Dunn) Jackling. Education, BS, Missouri School of Mines, 1892; Met E, 1900; hon. DE, 1933. He also held the following honorary degrees: DE, University of California, 1940; ScD, University of Utah, 1942. Married Virginia Joliffe, 1915. Fellow ASME, 1941. Mr. Jackling was also a member of the American Institute of Mining and Metallurgical Engineers of which he was director from 1925–1928; 1938–1941; president, 1938. He was councilor of the Mining and Metallurgical Society of America from 1939 to 1944; and a member of American Chemical Society; The Western Society of Engineers; American Institute of Electrical Engineers. Mr. Jackling received the U. S. Government Distinguished Service Medal and was honored by professional societies for his valuable contributions to engineering.

**Joseph Needham Kinney (1875–1956),** retired, died Jan. 1, 1956, at Lake Worth, Fla. Born, Hartford, Conn., Sept. 4, 1875. Parents, William Clarke and Sarah Elizabeth (Cross) Kinney. Education, attended Princeton University two and one-half years in BA course, with class of 1899. Married Lydia Wilkins Inskeep, 1904. Mr. Kinney specialized in friction-clutch controlled hoisting and excavating machinery. Assoc-Mem. ASME, 1914. Survived by two sons, Joseph N. Kinney, Jr., Carnegie, Pa.; Dr. Robert J. Kinney, Topeka, Kan.; and a daughter, Mrs. Emil H. Jensen, Lake Worth, Fla.

**Dana W. Kreidler (1884–1955),** experimental engineer, died Aug. 20, 1955. Born, Hornell, N. Y., Sept. 17, 1884. Parents, Walter R. and Laura (Clark) Kreidler. Education, BS(ME), University of Illinois, 1911. Married Bernice Pierce, 1917; son, William P. Kreidler. Mr. Kreidler specialized in automotive engineering. He started his career in the Erie Railroad Shops, Hornell, N. Y., and his last appointment was that of experimental engineer with the Hudson Motor Car Co., Detroit, Mich. Mem. ASME, 1917.

**Oscar Gowen Thurlow (1881–1956),** consulting engineer, died in Florida, Jan. 21, 1956. Born, Newburyport, Mass., June 7, 1881. Parents, Rufus and Angela (Short) Thurlow. Education, BS, Massachusetts Institute of Technology, 1904. Married Mary Brown; children, David and Elizabeth S. Thurlow. It was during Mr. Thurlow's engineering work with the Alabama Power Co., that the hydro plants now known as Lay Dam, Mitchell Dam, and Martin Dam, Upper Tallassee and Lower Tallassee Dams were built on the Tallapoosa River. During his period of service with the company the steam plants at Gorgas, Gadsden, and Mobile were constructed. In 1930 the State of New York appointed him a member of the Engineering Board of the St. Lawrence Water Power Development Division to study and advise the Committee on the development of the international section of the St. Lawrence River. Mr. Thurlow had an honorary DS degree from the University of Alabama. The Franklin Institute of the State of Pennsylvania awarded him the Howard H. Potts Gold Medal on May 16, 1928. Mem ASME, 1915.

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From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Division (no more than three) in which you are interested. Your membership card bears key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you are registered.

Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

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# Roundup

## Of Current Engineering Events, News, and Comment

E. S. Newman, *News Editor*

Dr. Schuberth addresses opening session of the 100th Anniversary Meeting of the Verein Deutscher Ingenieure, held in Berlin

## VDI Celebrates Its 100th Birthday—Honors Dr. L. M. Gilbreth

### Thousands of Engineers Meet in Berlin for International Technical and Social Event

**Reported by R. H. Bacon**[1]

With the deletion of a few personal remarks, we offer this report of the Verein Deutscher Ingenieure Hundredth Anniversary meeting May 12–15, 1956, based on letter No. 12, dated May 16, 1956, covering Mr. and Mrs. R. H. Bacon's trip to Berlin. A decided departure from our usual style of meeting report—the reason will be evident from the start.

After receiving their badges and programs for the meeting and meeting delegates and several friends, Mr. Bacon reports:

We got a better line on the VDI (Verein Deutscher Ingenieure) organization. Before the war it had a membership of about 60,000 made up basically of mechanical engineers, but also other engineers in related fields. It was organized on a regional basis but tied together with the national organization. The war completely destroyed the organization. They now have about 30,000 members and the registration for the Centennial was 3000 engineers and 1000 women.

During the afternoon we also saw the other members of our official American delegation, namely, Dr. Lillian Gilbreth, R. C. Allen of Allis-Chalmers, General S. E. Reimel, and Prof. E. C. Keachie and his wife, Grace. Other Americans who came for the VDI celebration were Mr. and Mrs. R. C. Burt, San Marino, Calif.; Dr. and Mrs. Royal Sorensen, AIEE, of Pasadena, Calif.

Mr. Bacon mentions that he and Mrs. Bacon met Dr. Gilbreth on Easter Sunday in Rome. The report continues, "The next we heard from her was through the Keachies while we were in Frankfort. Chet Keachie said she had had the misfortune to fall and break an arm, but even that didn't stop her. She was making a speech some place a hundred or so miles from Frankfort. So here she was in Berlin and before the VDI celebration was over she was to steal the hearts of the Germans as she has everywhere else throughout the world."

Some of us went over to hear Professor Keachie (Fulbright Fellow) make a talk to the students of the Technical University on industrial engineering and it was a good job. He has a very interesting method of tying in our free-enterprise system with industrial engineering and management.

That afternoon, May 12, there had been an official opening of the celebration at the Rathaus Schoneberg (city hall) and in the evening at 8:00 p.m., an informal party was held at the Pralat Schoneberg—a real German beer stube type of party. It must have been attended by 1000 engineers and their ladies.

On Saturday morning, May 12, the first big session got under way about 9:30 a.m. This was out at the Festhalle Ostpreussen am Funkturm (Festival Hall). It is really a tre-

[1] President, R. H. Bacon & Company, Chicago, Ill. Mem. ASME.

mendous layout and in one of the halls about 3000 engineers gathered to hear two lectures of a general nature. The one by Dr. R. Vieweg, president of the Technical and Physics Universities, presented the German viewpoint on the relation between the sciences and practical technology.

In the afternoon the sessions broke up into two groups—one on research and development and the other on design and construction. Such subjects as "Nuclear Energy," "Influences of Materials on the Development of Engineering," and "The Process—Technical Tasks of Engineers in the Development and Manufacture of New Products" were discussed at length in the Research and Development Session. At the Design and Construction Session papers covered "Design on the Basis of Model Tests," "Lightweight Construction," and "Beauty of Design." The German slant on these subjects is quite different from our American thinking and may give us an inkling as to the direction German engineering is taking.

At 5:00 p.m. there was a very fine complimentary social hour given by the VDI at the Hotel Gerhaus for the delegates, officials of the VDI, and foreign visitors. About 200 attended and the delegates presented testimonials of the various societies. Our ASME scroll was a work of art and one of the finest to be presented. The presentation was made by General Reimel.

The Hotel Gerhaus is quite a show in its own right. Built by the lawyer who handled the affairs of the Hohenzollerns, it is one of the few places left in Berlin that reflects the glory of departed days. It is out in the residential section and would make an excellent place to stay in Berlin.

At 8:00 p.m. came the Berliner Abend or Night in Berlin at the Festival Hall. We never did hear what the attendance was, but we would judge that the entire 3000 men and the 1000 women were there. Two enormous halls were used and each was set up with tables for from eight to 12 and there was a large stage and orchestra in each hall. Opera stars, vaudeville acts, and a boys' choir furnished the entertainment. There was also a childrens' ballet that was quite unusual.

**Dr. L. M. Gilbreth honored by VDI for outstanding research into motion problems**

On Sunday at 10:00 a.m. came a big session at the Festival Hall (with opening music by the Berlin Opera Orchestra) where Professor Dr. Suhr, Acting Mayor of Berlin, and Dr. Blucher welcomed the engineers. Dr. H. P. Schuberth, VDI president, in opening the Sunday morning session, also spoke at some length on the history of the VDI and its future. Dr. Choisy, president of the Switzerland Engineering Society, spoke on behalf of the foreign engineers present and Professor Dr. Pfender, who is president of what would correspond to our Bureau of Standards, delivered the principal address on "Man and His Technology"—a brilliant discussion of the relationship of religion, philosophy, and technology from the human side.

Then followed the presentation of honors and our own Dr. Lillian M. Gilbreth was given an ovation when she received the VDI medal for "outstanding research into motion problems"—for finding the one best way to carry out production tasks—for carefully fostering human relations.

The delegates then went to a complimentary luncheon at the Hotel Gerhaus. After a pleasant social hour with a wide assortment of libations, a dinner of fish, oxtail soup, rolled breast of chicken with sauerkraut and asparagus followed by an ice-cream bombe type of dessert was served. The proper wine for each course came in at the right moment with champagne to go with chicken.

Lillian Gilbreth spoke for the American delegation and made one of her usual heart-warming talks which she began in German and finished in English. We could see the Germans were pleased and touched.

On Sunday evening the VDI had arranged for us to buy tickets for either of two shows—Caesar and Cleopatra at the Schiller theater or Orpheus in der Unterwelt at the Stadtische Opera. Since our ability to understand German is so limited, we chose the opera. This is what we would class as a comic opera by Offenbach. We would say the opera is a little on the corny side but the music is beautiful. The overture is often played on the symphony programs and the can-can music has, of course, become world-famous and practically the national anthem of France.

The program on Monday morning at the Festival Hall consisted of two lectures, both on the broader aspects of technology on human relations. Dr. H. H. Kuhnke covered "Social Effects of Technology" and Professor Dr. S. Struger talked on "The Laws of the Spirit."

You will note that all through the program there was an emphasis on religion, philosophy,

**Some of the Americans who attended the VDI 100th Anniversary Meeting in Berlin, May 12–15, are, *left to right,* E. C. Keatchie, General S. E. Reimel, C. B. Molineaux, Royal Sorensen, R. H. Bacon, and R. C. Allen**

**Statue which was erected to commemorate VDI's 100th Anniversary exhibited**

psychology, and human relations, all tied in with engineering. We assume the experience of the past 20 years has had a profound effect on the German engineers and that they are going to take a more active part in helping to solve the human problems of Europe.

In the afternoon there were two important sessions—one on manufacturing and the other on the economics of distribution. "Principles of Fabrication," by Kienzle; "Flow of Material—First Step in Automation," by Kienbaum, and "Automation" covered the manufacturing phase.

Since Western Germany is probably the one spot in the world where American production methods are being utilized to an important degree, we found a keen interest in automation. Since the Germans say they are short some 30,000 engineers, they are thinking in terms of speeding up production with their present technological staffs.

It is also interesting to note that the engineers in responsible positions are either under 30 or over 50. During the war, the Germans lost practically all of their engineers in what would now be the middle-age group.

The problems of distribution were covered in three lectures—"The Engineer and the Distribution of Goods," by Jakopp, "Future Leadership," by Schlight, and "Industrial Legal Protection," by Radt.

On Tuesday a big sight-seeing tour had been arranged and one of the trips was to East Berlin. Only two buses were required for this trip—as, apparently, the West Germans are somewhat leery about going into East Berlin even on a tour.

Let me say that the no-man's land between East and West Germany is a terrible spectacle of desolation. There has been no rebuilding in the area where Hitler and Goebbels hung out. We were stopped by the Russian police a couple of times but my taxi driver, who looked like an ex-Nazi, got us out.

There is an air of tension in Berlin and we have a feeling from our talks with the German people that they are not at all hopeful of any early unification. One of the VDI men told us they had hired an engineer just recently who had left his home and possessions and had crossed the line never to return. This engineer had been hoping for a settlement but after the Geneva conference, he finally gave up hope. We feel that they are beginning to believe there will always be an East and West Berlin.

Our German visit has been most illuminating and we will have a better understanding of the entire European situation.

## Meetings of Other Societies

**July 16–21**
International Organization for Standardization, Geneva, Switzerland

**July 16–21**
French Association for the Advancement of Science, meeting, Dijon, France

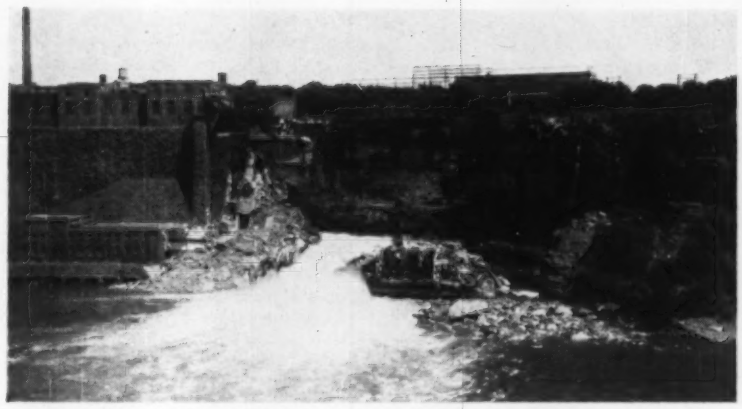
**Aug. 5–13**
Ninth International Congress of Applied Mechanics, International Union of Theoretical and Applied Mechanics, Brussels, Belgium

**Aug. 6–8**
Society of Automotive Engineers, West Coast meeting, Mark Hopkins Hotel, San Francisco, Calif.

**Aug. 15–17**
Institute of the Aeronautical Sciences, turbine-powered air transportation meeting, Grant Hotel; exhibition, IAS Building, San Diego, Calif.

*(ASME Coming Events, see page 669)*

**E. Hianne, secretary of the Royal Society of Belgian Engineers, chats with R. H. Bacon at one of the receptions in Berlin**



**On June 11, 1956, Herbert B. Reynolds, Fellow ASME, photographed the scene of the rock slide of June 7 at Niagara which crippled the Schoellkopf hydroelectric station of the Niagara Mohawk Power Corporation. Water from the canal on the top of the cliff is seen rushing into the river over the ruins of the station, *center*. The undamaged portion of the station is seen at *left*.**

# Niagara Falls Disaster Recalls Significance of First Large-Scale Hydroelectric Plant

THE rockfalls which destroyed a considerable portion of the Schoellkopf hydroelectric station of the Niagara Mohawk Power Corporation at Niagara Falls, N. Y., on June 7, provides an appropriate occasion to recall the origin and significance of hydropower at Niagara. In a way the successful generation and long-range transmission of polyphase alternating current in large quantity at Niagara was as great a milestone in 1896 as atomic power is in our own generation.

From a brief account of the original Niagara project which appeared in the September, 1936, issue of this magazine the following portions are quoted:

Few projects in America have so long a history; with few engineering projects have such great names been associated. From the time when Chabert Joincaire, Jr., first utilized a six-foot fall in a loop canal in 1757 to the present the challenge of harnessing an enormous "free" power has engaged men's skill. Every advance has reflected progress in technology and has called for courage and faith. The very difficulties of the problem of effective utilization seem to have called forth the human energies necessary to surmount them.

A varied financial, industrial, and engineering history preceded the formation of the Cataract Construction Company in 1889, beginning with the developments of the Porter brothers in 1806 and culminating in those of the famous Schoellkopf family, still associated with the project. But the period of greatest significance at Niagara Falls began with the undertakings of the Cataract Construction Company.

In this period decisions of far-reaching importance were made, and developments of permanent influence on the power industry were undertaken. Financial, legal, scientific, and engineering talent of the highest order were combined and skillfully co-ordinated under the leadership of Edward Dean Adams, whose two-volume history, "Niagara Falls," has placed all these matters on record. In the brief space available here it is possible to mention only a few of the significant factors of Niagara development, but these it is important to remember.

Prominent among these factors is the exhaustive effort made by the Cataract Construction Company to secure the best scientific and engineering advice on the proposed development, which led to the formation of the famous International Niagara Commission, whose members—Lord Kelvin, Coleman Sellers, Professor Mascart, Colonel Turrettini, and Professor Unwin—guaranteed its high international reputation.

With rapid advance of the engineering profession in this country we are likely to forget the acknowledged British and Continental leadership in engineering that sent Dr. Adams abroad in 1890. The subsequent actual developments at Niagara formed an effective step in growing confidence in the capabilities of engineers and manufacturers in this country to undertake large and pioneer projects. Furthermore, Niagara affords an early example of independence of Europe in the financing of such enormous ventures.

## Unwin's Comment

To quote from an obituary of the late William Cawthorne Unwin, secretary of the International Niagara Commission, that appeared in the December, 1935, issue of MECHANICAL ENGINEERING, pages 811–812—The modern age to which the younger engineers now practicing belong finds it hard to understand the uncertainties that faced this Commission. For the generation of electricity in large amounts by hydraulic turbines, the transmission of the current generated over long distances, its distribution and use in mechanical and chemical industries, and hundreds of technical problems such as the relative advantages of alternating and direct current were being attacked in pioneer fashion. Nor was it certain that the development should be an electrical one. Electricity was new; it had never been generated centrally in large quantities for distribution over long distances to points where it could be used. While lighting by electricity had been broadly introduced, industrial power was still largely by mechanical means. The Evershed project, upon which the Niagara scheme was based, was entirely hydraulic and contemplated a community of industries deriving their power from individual hydraulic turbines fed from a common canal—the use of power at the site. Mechanical (telodynamic) and pneumatic trans-

**Sheet piling being driven at the entrance of the canal feeding the Schoellkopf station of Niagara Mohawk Power Corporation to shut off flow of water. Photo taken by Herbert B. Reynolds, Fellow ASME, on June 11, also shows rubble being dumped behind the piling.**

mission systems were in a position to contend for consideration with hydraulic, steam, and gas methods of transmission and distribution. Moreover, the machinery and auxiliary apparatus, as well as the construction of the hydraulic details, were of a scale heretofore untried, so that the stakes, engineering as well as financial, were high and hazardous...

Writing 25 years later of the work of the Commission, Professor Unwin said: "The projects were of extremely varied character. Hydraulic turbines of impulse and reaction types of from 2000 to 10,000 horsepower; distribution by electricity, by compressed air, and by wire ropes. Most of the electrical schemes proposed direct-current production and distribution with varying current and constant voltage. Messrs. Siemens proposed constant direct current at varying voltage; Professor Forbes only proposed alternating current. From the first, electrical distribution of the power was in favor, but was not definitely decided upon until May, 1893." Of the significance of the project itself he wrote: "Civilization may be measured by the degree in which human labor is replaced by power derived from natural sources of energy..... At Niagara some 7 million horsepower which might have been available for industrial purposes was being wasted. The conditions were favorable for utilization in other respects for the fall was a high one and the Great Lakes from which the water flows act as reservoirs equalizing the supply. The installation has been carried out with complete success, and it is the first large-scale undertaking of the kind. It has been the parent of many others in different parts of the world, or at any rate showed the way to others to achieve a similar success. But the risk of misadventure in so novel and complicated an enterprise in the days when it was carried out was great, and that no serious mistake of judgment or calculation occurred witnesses to the remarkable care with which the preliminary investigations and discussions were conducted."

### Westinghouse Pioneering

Speaking at the 90th Anniversary of George Westinghouse (MECHANICAL ENGINEERING, April, 1937) L. B. Stillwell, who had been active in the electrical development at Niagara, said:

"Niagara presented an extraordinary opportunity to launch the polyphase system. It all seems obvious now, but, at that time, even Lord Kelvin, president of the Niagara Commission, which Mr. Adams organized, strongly opposed alternating current. The great need was a convincing demonstration. Westinghouse provided it. His bold adventure at the Chicago World's Fair in 1893 is a well-known story; apparatus not yet designed was essential; a patent injunction against the use of the 'all-glass-globe' incandescent lamp was met by the stopper lamp. The result was a convincing demonstration of the polyphase system. As the Fair closed a contract was executed for three two-phase alternators of '5000 electrical horsepower.' The plant began operation in 1895, and, in November, 1896, Niagara power was transmitted to Buffalo. Lord Kelvin approved. A decade of electrical pioneering and development, beginning with the little single-phase lighting plant in 1886, ended with the polyphase plant at Niagara for supplying universal service. It laid the foundation in engineering system and in commercial confidence for the electrical-power expansion that has followed. Westinghouse's vision of an electrical power system was realized."

# How Industry Can Stimulate Interest in Technical-Society Work

INDUSTRY can foster professional development and a more effective technical society by recognizing its "obligation to provide the engineer with opportunities and encouragement to participate in technical-society work," says J. S. Alford, Mem. ASME, General Electric Company, Cincinnati, Ohio, in the May-July, 1956, issue of *General Electric Review*.

Citing the technical society as one of the most effective means to attain professional development—a good technical society breaks down the barriers of specialization and brings its members to a better understanding of each other—Mr. Alford lists four ways industry can help its engineers to participate in technical-society work: (1) Create an encouraging climate and atmosphere of enthusiasm; (2) promote individual activity among the members; (3) assist engineers in preparing papers and performing committee work; and (4) publish information and keep suitable records.

"Some progressive companies," he points out, "maintain staff consultants in matters of professional relations. As part of their responsibilities, they work not only with engineering managers to stimulate interest in technical societies, but also directly with the societies themselves."

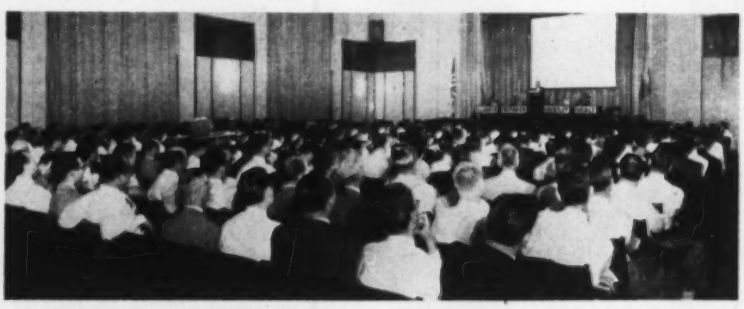
The company can substantially back up the engineer's enthusiasm in technical-society work by paying the expenses when these become burdensome for the individual, where travel to national meetings is involved; sponsor memberships in certain societies, and publicize society information of particular interest to engineers in the industry. Membership dues are usually the individual's expense; but when an engineer is already a member of one leading society, it may be to mutual advantage for the company to finance the cost of the engineer's membership in additional societies. In return the engineer is expected to present papers before the society and accept committee assignments.

"Experience indicates," says Mr. Alford, "that engineers go to meetings because they're interested in the program and hope that it will contribute to their professional development. No society can flourish without this interest. [General Electric's] Jet Engine Department believes that providing adequate opportunity for continued education has been one of the principal means of stimulating interest in professional development." The Jet Engine Department at Evendale, Ohio, has 700 engineers enrolled in 19 specialized technical courses and as part of its Technical Education Program offers refresher courses to prepare students for the Ohio examination for professional registration.

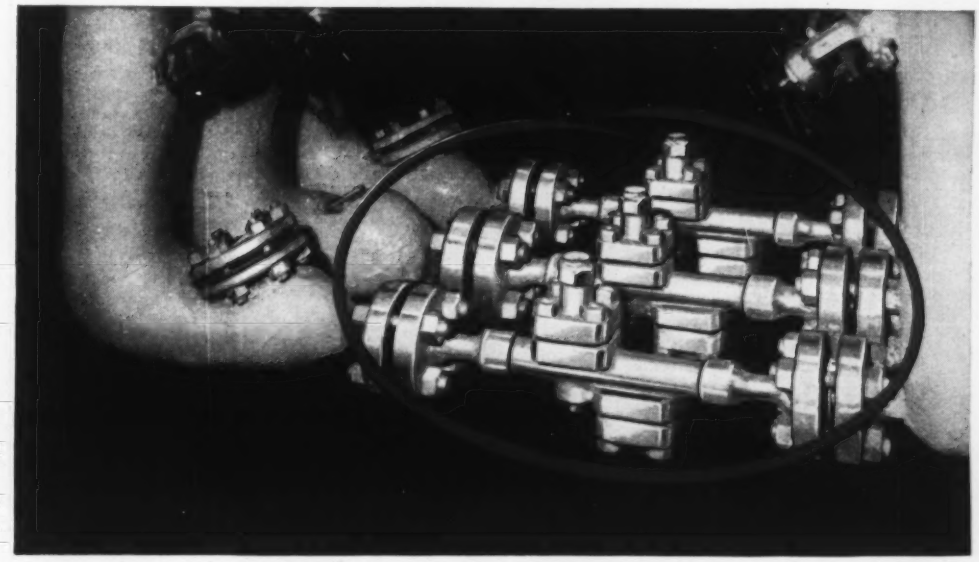
The engineering manager can most effectively encourage individual participation in technical-society work simply by being there himself; he could introduce the young engineers and perhaps even get up a party to leave from the office together. Most societies require a sponsor for the new member; senior engineers should offer to sponsor anyone interested. The senior engineer or manager has a responsibility to acquaint junior engineers with the functions and benefits of technical societies of which he is a member or which may be of interest to engineers in the industry.

To encourage a young engineer to present a paper before the technical society once he has company permission, as the paper usually deals with company business, the company can do more than grant permission. He can be assisted in preparing the paper, by having the help of a typist, a draftsman to prepare slides, and the company should help if there is any other expense involved.

*(Roundup continued on page 688)*

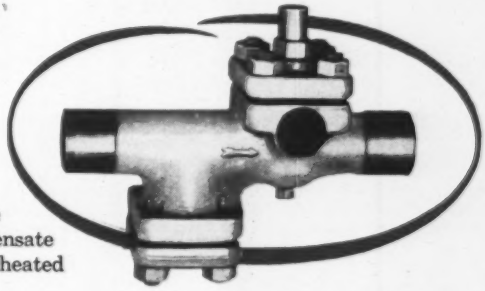


**What happens when industry and a professional society join forces? View of technical session during the recent ASME Design Engineering Conference held concurrently with the Design Engineering Show in Philadelphia, Pa.**



*Three Yarway Integral-Strainer Impulse Traps draining main steam lines in large mid-west power plant. Other Yarway traps drain extraction lines in same plant. Yarway Integral-Strainer Impulse Traps are available with welding or flanged connections. Pressures 600, 1500 and 2500 psi.*

# HIGH STEAM PRESSURES AND TEMPERATURES CALL FOR YARWAY INTEGRAL-STRAINER STEAM TRAPS



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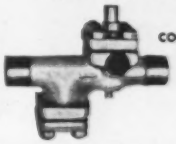

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"A definite correlation exists between an engineer's skill in written and oral communications and his participation in technical societies," Mr. Alford said. If being ill at ease on a speaking platform, or nervous about joining in discussion makes the young engineer hesitant, everything possible should be done to help overcome the problem and recognize the great importance of developing skill in speaking and writing.

A company can also foster participation in technical societies by maintaining thorough records. An engineer cannot join a technical society or attend a meeting unless he knows about it. Companies should have all the facts and publish them either in their own bulletins or by distributing society pamphlets. They should also record the preferences of their engineers—only they know best what contributes to their professional development.

The company bulletins, or other means of communications, should inform engineers about awards and honors conferred by leading societies. "Awards to younger men spur them on; awards to eminent men recognize achievement."

# M. J. Kelly Urges Five-Year Engineering Course at ASEE Meeting

Our nation is engaged in a technological race for strength, declared Mervin J. Kelly, president of Bell Telephone Laboratories, and urged that we move ahead as fast as we can.

Speaking at a conference of more than 300 members of the American Society for Engineering Education, Dr. Kelly described the nation's expanding need for scientists and engineers and emphasized the need for more and better training of both research and development people. He also suggested that educators consider establishing a five-year basic engineering course in place of the traditional four-year course so that students would receive more engineering fundamentals.

The conference was the Spring Meeting of the ASEE Middle Atlantic Section, held May 12 at Bell Telephone Laboratories, Murray Hill, N. J.

Concerned with the critical shortage of engineering graduates, the all-day conference had as its theme the "Preparation of Engineering Students for a Career in Industry." Dr. Kelly's keynote address was on "Preparation for a Career in Development and Research."

In stressing the need for more and better engineering training, Dr. Kelly pointed out that the four-year engineering graduate generally lacks sufficient training. He showed how Bell Laboratories' belief in more education is exemplified in the Communications Development Training program, established in 1948 as a three-year course for newly employed engineers with bachelor's and master's degrees.

In suggesting a five-year engineering course, Dr. Kelly explained that it could be arranged so that students could stop at the end of four years or continue for the fifth year. This fifth year would be advisable, regardless of whether the student went on for a doctor's degree.

Dr. Kelly also urged industry to place greater emphasis on basic research and recommended that research activities be separated from activities relating to development and design.

He described the successful experiment of Bell Laboratories which 20 years ago separated research from the development and design functions within the company. He explained that the Laboratories worked to create an environment of freedom comparable to that found on university campuses—freedom in research, freedom to publish, and freedom to intermingle with scientific people throughout the world. "The results of the work done in this area of basic research have created a reservoir of knowledge which, for a long time, will contribute to improvements in communications," he said.

Dr. Kelly also insisted that the research scientists must have the freedom to wander into the area of tomorrow.

Important problems in the field of engineering education were discussed at three afternoon meetings, as follows:

"Preparation of Engineering Graduates for Industry"—Chairman: Sydney B. Ingram, director of education and training at Bell Laboratories. Speakers: Morris D. Hooven, Public Service Electric & Gas Company and president of the AIEE; Henry N. Meixner, general assistant director, Mechanical Development Laboratory, E. I. du Pont de Nemours & Company; and F. W. Miller, vice-president (manufacturing), Yarnall-Waring Company, Philadelphia, Pa., and Vice-President ASME, Region III.

"Preparation of Secondary School Graduates for Engineering"—Chairman: Elmer C. Easton, dean of engineering, Rutgers University. Speakers: Lynn L. Merrill, dean of the Faculty, Stevens Institute of Technology; Harold K. Work, director of the Research Division, College of Engineering, New York University; and Ablett H. Flury, Assistant Commissioner of Education for the State of New Jersey, who delivered a paper by Frederick Raubinger, Commissioner of Education.

"Current Engineering Manpower Needs in Industry and the Colleges"—Chairman: Donald S. Bridgman, director of College Relations, A.T.&T. Company. Speakers: William T. Cavanaugh, Executive Secretary, Engineering Manpower Commission of the Engineers Joint Council, and Robert W. van Houten, president, Newark College of Engineering.

Mr. Cavanaugh described much of his work as a "pulse reading of industry, seeking to establish any trends in employers' recruiting, the development of employment trend information."

To illustrate the increase in need for engineering graduates, Mr. Cavanaugh cited a survey made late in the fall of 1955 among 415 industrial companies and governmental organizations employing engineering graduates. The 415, as a matter of description, employed a total of about 3 million workers, 140,000 of which were engineering graduates. The purpose of the survey was to determine 1955 employment results and obtain an estimate of 1956 intentions—and by comparing, see trend.

These are the results: In 1955 these 415 had an engineering personnel increase, or "accession" of 8000; and the same organizations estimate an accession of 12,500 in 1956. This

(*Roundup continued on page 690*)

**Some of the 300 engineering educators and industrial representatives attending the ASEE conference pass the Bell Laboratories technical library on their way back from the morning session at Arnold Auditorium**

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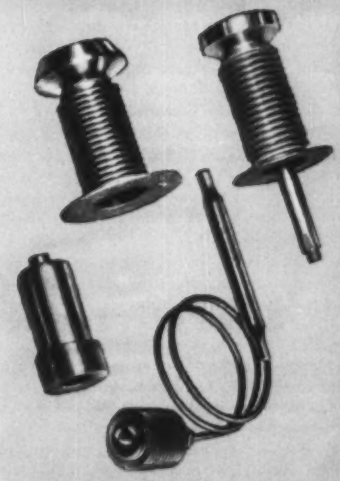

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is about a 40 per cent increase. (Accession was defined as the sum of all new hires, plus those returning from military leave, minus those leaving the companies for one reason or another.)

He noted a steady growth of demand for engineers with doctorate degrees, a demand incidentally concentrated in the electrical, chemical, and transportation industries since these have the larger research programs. The demand for PhD's was estimated at 600 for 1956—presumably for the 415 afore-mentioned organizations.

On slightly different subjects, Mr. Cavanaugh noted that in Great Britain the British feel the future of Britain rests almost completely on her capacity for technical achievement and progress. In West Germany, he said, newspapers are astonished by the impressive fact that an increasing number of technical graduates in all levels are employed before graduation.

In answer to a question from the audience, Mr. Cavanaugh said he felt that, with regard to competition with Russia, there was some danger in taking the approach of trying to win a quantitative race for technological manpower since Russia simply has a considerably larger population and presumably could, if desired, create a larger quantity of engineers and scientists. The emphasis would have to be on other aspects of the competition as well in the future.

Following dinner at the Hotel Suburban in Summit, N. J., William E. Burke, vice-president—Defense Projects, Western Electric Company, gave a recently declassified account of construction of the Distant Early Warning Line which guards our arctic continental approaches.

Arrangements for the conference were made by a Laboratories committee headed by Frank D. Leamer, personnel director.

# J. C. Ward Says Energy Sources to Be Exhausted in 100 Years

Two hundred businessmen from the United States and Mexico heard specialists in all fields of atomic energy discuss the peacetime uses of atomic energy at the Atoms in Business Conference sponsored by Southwest Research Institute and Southwest Foundation for Research and Education and the Atomic Industrial Forum, Inc., at the Plaza Hotel, San Antonio, Texas, May 10–11.

J. Carlton Ward, Jr., Mem. ASME, president, Vitro Corporation of America, who spoke at the first day's luncheon, gave the group something to worry about.

"All our present energy sources, including uranium and thorium, will be exhausted within 100 years," Mr. Ward said. He called for an expanded program of basic research to develop a better utilization of our energy resources.

Mr. Ward equated the American standard of living with the development of additional energy sources and warned unless the problem is solved dwindling energy resources will cause a considerable decline.

General William H. Draper, Jr., chairman of the Mexican Light and Power Company, told the audience that the Latin-American countries are experiencing a serious shortage of light and power. Of the four largest Latin-American cities, he said, Mexico City alone has had sufficient light and power.

He stated that foreign capital is necessary if Latin America is to build to meet its basic power needs. He warned that an advance in the investment return would be necessary before foreign investors would be interested. (U. S. utility investments yield approximately seven per cent while it has been reported that Latin-American investments yield only four per cent.)

General Draper said he saw a steady but gradual increase in the development of electrical power from atomic energy. He said the first step would be the installation of experimental reactors, next the construction of small-size atomic plants for training and experience, and finally in five to ten years, large-scale atomic-energy plants.

William B. Mather, chairman of the department of mineral technology of Southwest Research Institute, said the United States is a "have nation" in respect to the materials of nuclear energy despite the statements to the contrary.

Of the 22 elements used in atomic-energy work, the nation has an ample supply of the raw materials for ten, including thorium, a "fertile" material which can be converted into fissionable uranium-233 in breeder reactors, Dr. Mather said. In the event of a national emergency, this country, especially with the assistance of our neighbors, Mexico and Canada, could supply six more including uranium, the other reactor-fuel source. Normally, in peacetime, for economic reasons, it depends upon imports to supplement its own deposits of these elements.

Six of these elements are in short supply, Dr. Mather stated. But of these only beryllium is used extensively in actual reactor operation. It is used as a moderator to increase the efficiency of reactors.

He also said we could improve our position further by additional research programs in mineral technology.

The oil industry's relation to atomic energy was considered by Frank Norton, chairman of the Texas Committee on Atomic Energy; John C. Allred of the University of Houston, and John C. Hume, president of Technical Services, Inc.

Mr. Norton outlined the work of the Texas committee. He pointed out that until standards are finally determined, such matters as radiation-danger control will be dealt with by regulation rather than law. He further said the state would recommend the acceptance of uniform standards based on suggestions by the Atomic Energy Commission.

Mr. Allred stressed the fact that atomic energy should be seen as a partner rather than a competitor to the fossil fuels. He pointed out that petroleum and other fossil fuels are valuable as a source of chemical raw materials.

Mr. Hume said that differing conditions in the Southwest rule out, at present, the development of electrical power by means of atomic energy. He said those who say that oil and gas reserves will be depleted in a few years "more likely reckon without the knowledge of the oil and gas that may underlay further reaches of the Gulf of Mexico or the oil shales of Colorado, or perhaps some process which will make the question academic."

Walker Cisler, Fellow ASME, president of Detroit Edison, stressed the need for an informed management to cope with the changing conditions in the atomic age.

Copies of the proceedings are available for $5 by writing C. W. Smith, Atoms in Business Conference, Southwest Research Institute, 8500 Culebra Road, San Antonio 6, Texas.

**Charles Robbins, executive manager, Atomic Industrial Forum, *left,* confers with J. Carlton Ward, Jr., president, Vitro Corporation of America, and Harold Vagtborg, president, Southwest Research Institute**

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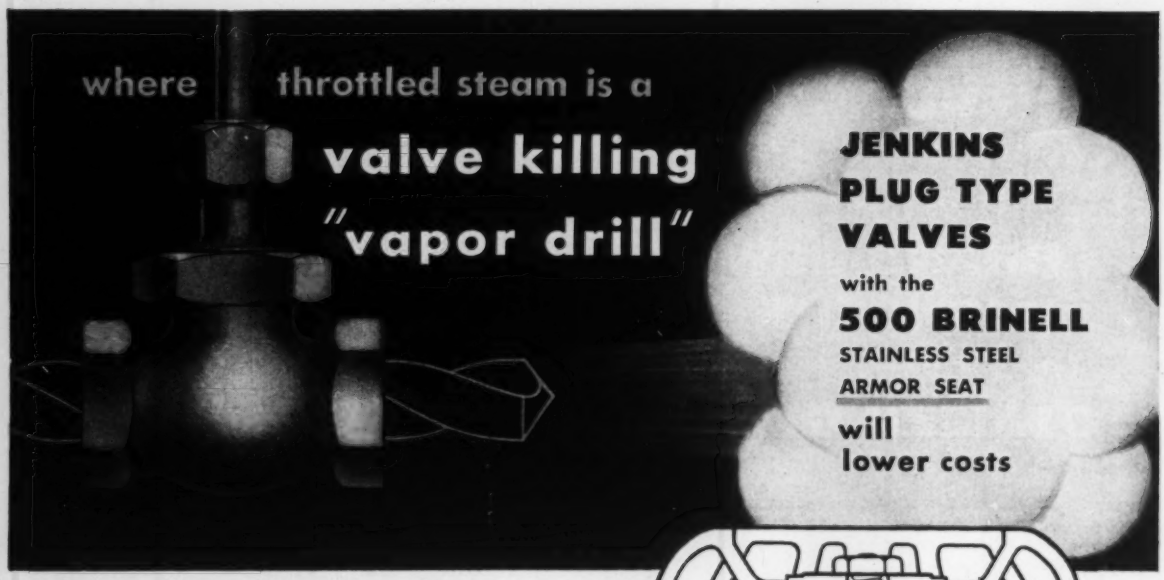


Closely regulated steam erodes grooves in seating units and drastically cuts service life of ordinary valves.

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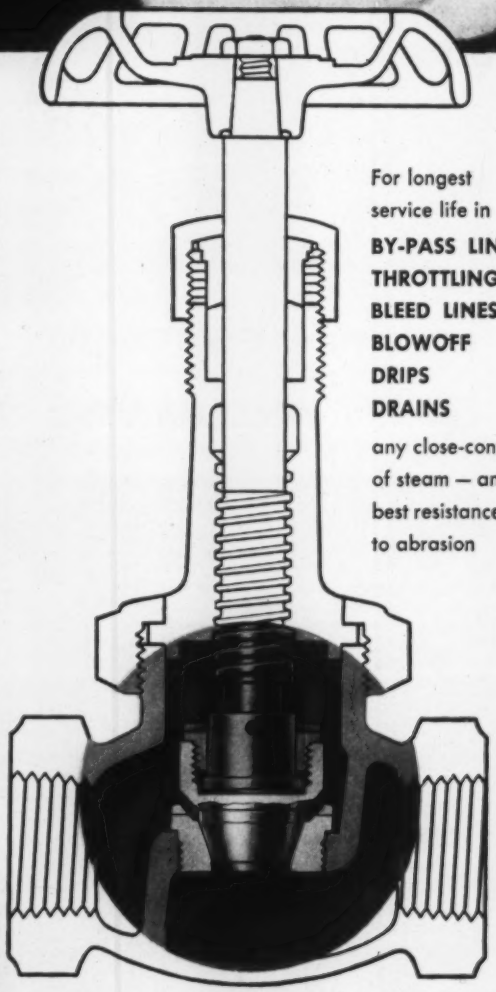
The Stainless steel plug is securely fastened to the spindle with a bronze locknut. Spindle is Jenkins specification bronze with a tensile strength exceeding 60,000 lbs., — has high corrosion resistance.



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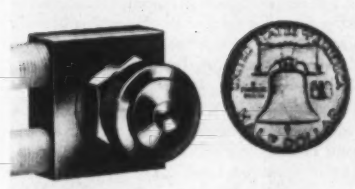


### Atomizing Nozzle

For pneumatic atomizing nozzle applications where space is at a premium, new small-size 6552 1/8 JAC nozzles are being introduced by Spraying Systems Co., 3265 Randolph St., Bellwood, Ill. Overall, the body is 1 1/4 in. high and 1 9/32 in. wide, about equal to the diameter of a half-dollar.

The nozzle is equally compact in front-to-back dimensions, the body itself measuring only 1/2 in. Depth of the nozzle cap and set-up will depend upon type employed. Since both liquid and air inlets are on the same side, this also helps in compactness of installation, the company states.

The new pneumatic atomizing nozzle is supplied in a wide range of capacities in choice of round, wide angle round and flat sprays, made in brass or stainless steel.

### Safety Rotor Turbine

L. J. Wing Mfg. Co., Linden, N. J., announces the availability of turbines with all-steel welded rotors. This rotor, the manufacturer claims, is one of the safest on the market.

The buckets are of nickel steel, precision welded to the periphery of the rotor and capped by a steel shroud, also welded. Should a turbine lose its load, accompanied by governor failure, instead of speeding up to destruction, the buckets would be released from the rotor at the weld, thus removing the steam impingement forces on the rotor, the company explains.

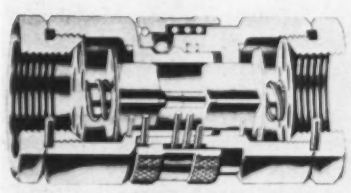
The speed at which the buckets will disengage is several times the maximum operating speed of the turbine but well below the rotor's breaking point.

### LP-Gas Conversion

Industrial Gastruck, Inc., 2091 Dempster St., Evanston, Ill., announces a pre-assembled kit for converting all makes of industrial lift trucks to LP-Gas operation easily in 3 to 4 hours.

Emphasizing the ease of installation, the firm says all lines, fittings and carburetion assembly are mounted for bolt-on arrangement. Parts are made to the proper size to fit any model, make, shape or size of truck, and are clearly identified for installation.

The kit comes with fuel cylinder bracket, toggle and strap to hold cylinder in position and location pin to carburetion linkage. The kit adheres to maximum safety standards and is approved by Underwriters' Laboratories and insurance underwriters, the firm states.

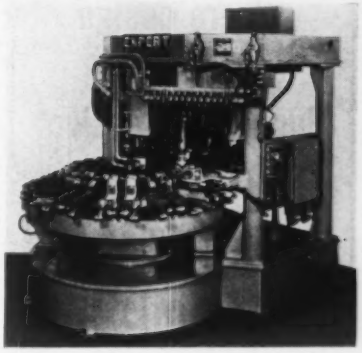


### Quick Coupling

A new quick connect-disconnect coupling for acids, alkali, solvents, high pressure steam is announced by Snap-Tite, Inc., Union City, Pa.

Known as the "HK" coupling, its use is limited only by the ability of its Teflon nipple seals and valve seals. The manufacturer states that this is the first successful field-tested quick-connect coupling using Teflon seals throughout. The "HK" will function perfectly through a −100 F to a +500 F temperature range and can be subjected to lower and high temperatures for short periods, the company says.

The coupling, which is manufactured from solid bar stock, can be furnished in 303 and 316 stainless steels, brass, aluminum, special carbon steel, or from any machinable material. The coupling is available without valves or with automatic shut-off valves incorporated in either or both ends, causing the valved end of the line to shut off immediately and automatically upon disconnection. When connected, the coupling valves automatically open.



### Index Welder

A new automatic 12-station index welder which features a continuous-running cam drive that controls index and weld sequences is now available from Expert Welding Machine Co., 17144 Mt. Elliott Ave., Detroit 12, Mich. The firm states that use of this type of drive simplifies sequence timing functions; the welds are made when the 5-rpm cam is in dwell position.

The machine illustrated welds 1200 two-piece, right-and left-hand automotive hood hinge stampings together per hour with nine spot welds. Both right-hand and left-hand parts are welded on the machine in adjacent fixtures on the 6-ft diam index table. The parts are clamped in the 24 fixtures by stationary air-operated clamps at the welding stations. Both transformers and hydraulically powered welding guns for the four weld stations are suspended from an upper platform supported by four tubular steel columns.

Since both right-hand and left-hand parts are welded on the machine, unique air-operated ejector mechanisms are provided at separate stations to separate the right from the left-hand parts and deposit them on individual conveyors. A part detector mechanism checks each fixture for load condition at a station ahead of the weld stations and shuts off the machine if no part is in the fixture.

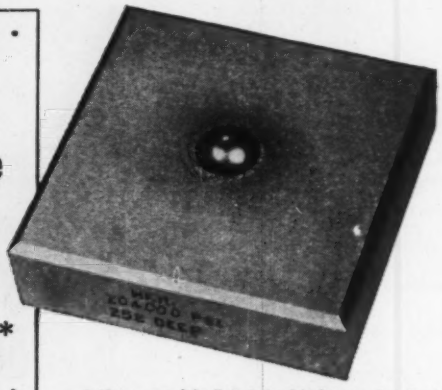
To operate the machine, the fixtures are manually loaded and the cycle button pushed. The operation from this point on is entirely automatic, with each fixture being manually loaded as it is indexed to a position in front of the operator.

The welder occupies a floor space about 7 by 8 ft and is about 7 ft high. An integral motorized hydraulic pump and tank unit is supplied with the machine for providing hydraulic power for welding gun operation.

A Kennametal ball pressed to a depth of .203" into a 1095 steel plate of 35 Rockwell C hardness, under pressure of 306,000 psi

A steel ball cracked when pressed to a depth of only .095" into a 1095 steel plate (35 Rockwell C), under pressure of 198,000 psi

Where design calls for high compressive strength . . . use KENNAMETAL*



A Kennametal ball is imbedded to a depth of .252" in meehanite plate under pressure of 204,000 psi

Among the many unusual characteristics of Kennametal is its high compressive strength, which is higher than that for virtually all melted and cast or forged metals and alloys. In a series of tests, Kennametal balls and steel balls were impressed into various types of steel plates. In one test, 1095 steel heat-treated to 35 Rockwell C hardness was used. Steel balls cracked when impressed to a depth of .095" under pressure of 198,000 psi, while Kennametal balls were pressed, with no permanent deformation, to a depth of .203" under 306,000 psi (the limit of the testing equipment). Another Kennametal ball was imbedded in a meehanite plate to depth of .252" under a pressure of 204,000 psi.

This exceptional compressive strength of Kennametal, combined with its high Young's Modulus of Elasticity and its hardness, makes Kennametal the ideal material for such applications as compressor cylinder liners, rolls for cold rolling of steels, rams, dies, grippers, valve seats and other applications where deflection or deformation must be controlled within close limits. Kennametal balls, for example, are used for accuracy in hole sizing and to impart a mirror-like finish to the bore.

Here is a material that may be the answer to your problem, and help you get your idea off the drawing board into production. Why not discuss it with our engineers or write KENNAMETAL INC., Latrobe, Pa. Ask for copy of a new booklet B-222, "Designing With Kennametal."

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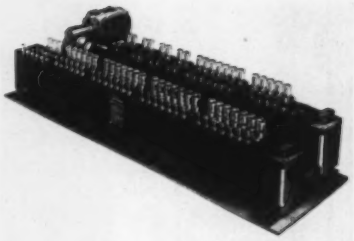

## Pumping Unit

This special 82-V vacuum type pumping unit was especially designed to meet the needs of a large compressor manufacturer and is being installed in one of the new ammonia plants in the United States by Manzel, Div. Houdaille Industries, Inc., 315 Babcock St., Buffalo, N. Y.

The lubricators are driven by one common gear motor and the drive is taken from the back lubricator into the front lubricator by way of a geared shaft. The bracket which supports the lubricators incorporates an oil pan which catches the drippage of oil from the lubricators in case one of the men should overfill the lubricator housing. According to the company, one of the big advantages of this lubricator is that regardless of how small the setting is for the oil delivery the plunger stroke remains the same. To change the volume of oil delivered only the position of the plunger in relation to inlet port is changed.

## Trolley Conveyor

Chain-O-Flex Corp., 3334 Lincoln Ave., Franklin Park, Ill., announces a new series of I-beam trolley conveyors called T-100 for operation on either 3 in. I-beam or $2^1/_2 \times 2^1/_4 \times {}^1/_2$-in. T-beam, for conveyor jobs under all types of conditions in ovens, spray booths and for dips.

The T series features the firm's special design chain with an ultimate strength of 18,000 lb. This type of chain is less expensive than forged chains, and has the economy of cable, the firm claims, adding that the chain will not fray or become weakened by flexing, nor is it subject to twisting or stretching.

A unique 2-piece positive grip design trolley eliminates the need for load pendants. Trolley spacing 8, 12, 16, or 24 in. centers. Trolley capacities range from 80 to 160 lb and can be doubled by the use of load bars. Trolleys are of bolted construction. Wheels are ball bearing and are grease packed at factory. The Series 100 is said to be especially practicable for operation in high temperatures up to 350 F.

Vertical curves of track can be furnished to requirements, ranging from $3^1/_2$ ft radius, up. Horizontal turns are made around traction wheels of either 23 in. PD or $30^3/_8$ in. PD and are available in 45, 90 and 180 deg turns.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Pipe Sealing Compound

A new chemically inert pipe joint compound said to positively seal practically all known highly corrosive liquids and solvents has been developed for services up to 212 F by Crane Packing Co., Dept. MXN, 6400 Oakton St., Morton Grove, Ill.

Known as "John Crane" Chemlon pipe joint compound, its base is Teflon. This material is said to be impervious to all types of hard-to-handle fluids and to possess an extremely low coefficient of friction. The latter substantially reduces wrench torque, permitting connections to be drawn up to a greater degree of tightness without undue stress or strain, the firm states.

The non-adhesive quality of Teflon and the non-hardening characteristics of the compound allow the connections to be quickly and easily disassembled, even after years of severe service, according to the company. The pipe joint compound is said to be particularly adaptable for use on aluminum, stainless, monel or plastic pipe and is currently available in 2-oz screw-type jars.

## Bronze Gate Valves

A new line of standard bronze gate valves featuring the new cylindrical design is now in production at the Kennedy Valve Mfg. Co., Elmira, N. Y.

The 125-lb bronze gate valves for steam, water, oil or gas, are available in screwed, solder joint and brazing socket ends. Sizes are from 1/4 through 3 in. The firm says special accelerated-wear tests conducted with the valves prove that the cylindrical construction results in more than 10 times longer leak-proof operating life than oval body valves.

Other features of the new design include a pistol-grip handwheel combining a firm, easy three-way grip; a new improved impregnated plastic packing material selected because it maintains resiliency and resists leakage longer; heavy pipe-end hexes for maximum strength; extra weight for more durability.

## Monorail Blast Cleaner

Wheelabrator Corp., Mishawaka, Ind., announces its new UB monorail-type blast cleaner, intended for handling cleaning problems involving parts with internal open cavities that are difficult to clean completely. The firm says typical applications are the cleaning of cast automotive engine blocks and the etching cleaning of welded water heater tank shells before glass lining or porcelain enameling.

The new machine, an airless abrasive blast cleaner, differs from older and conventional designs in that more efficient use is made of the blast cleaning abrasive. Fewer centrifugal abrasive-hurling units are required. The new design places the work to be cleaned in such a position that cavities are exposed to the abrasive shower from a single hurling wheel during the entire period the piece is in blasting position.


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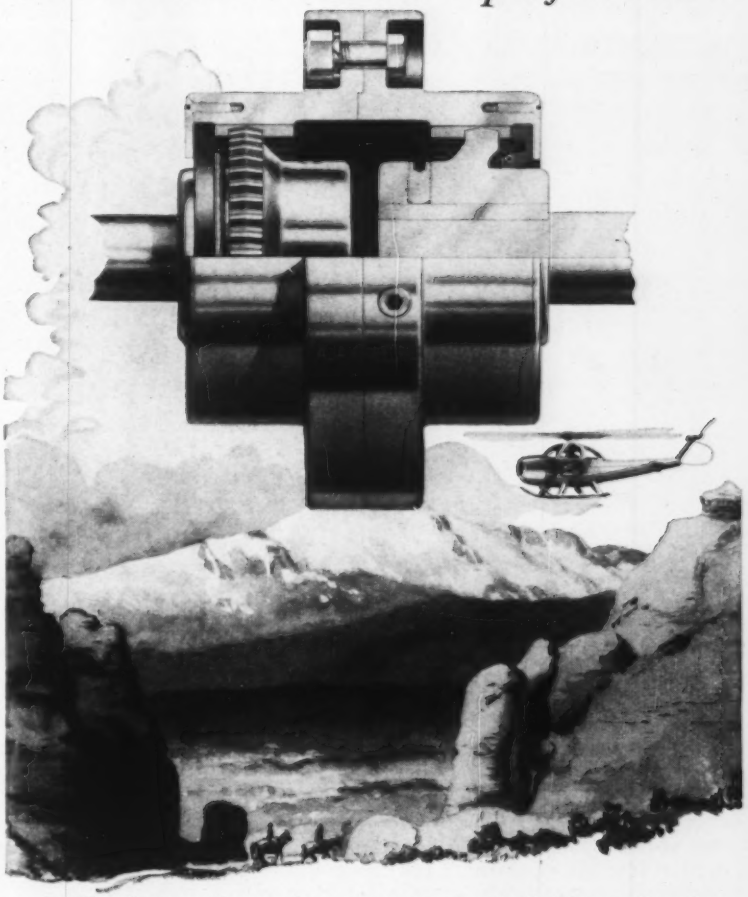


▶ The shortest distance between two points is via Ajax equipped helicopter. On September 13, 1955, a Cessna Helicopter driven by a Continental 260 H. P. power plant settled to a landing on the summit of Pikes Peak!

An Ajax Dihedral Floating Shaft Coupling delivered the power and handled the misalignment between motor and vertical drive unit.

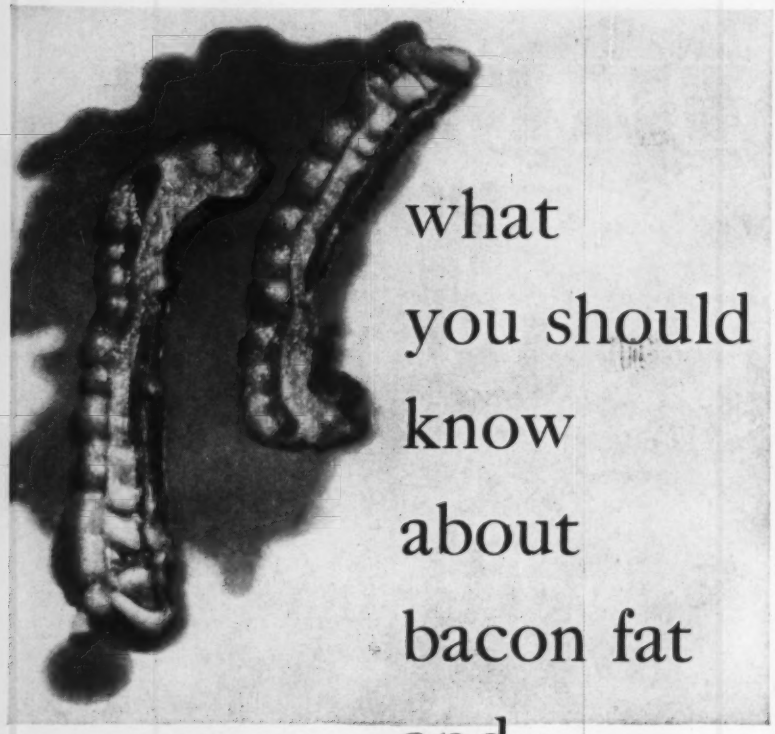
This is one more dramatic performance test of Ajax Dihedral Couplings.

They are handling alignment and misalignment problems on difficult installations including steel mills, cranes, oil drilling rigs and a host of other severe installations.

Every man responsible for performance, from design engineer to service manager owes it to himself to get the story on Ajax Dihedral Gear Type Couplings, the greatest improvement in couplings since the beginning of the industry. Write for full information right now.

**AJAX FLEXIBLE COUPLING CO. INC.**

*Representatives in Principal Cities* **WESTFIELD, N. Y.**



what you should know about bacon fat and Albanene®

**Here's the buying information you should have to get the *best* value when you buy tracing paper.**

1. **The usual way** of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

   **Result:** Valuable drawings on ordinary tracing papers eventually become yellow or brittle—lose their reproduction qualities. And, these days, replacements often cost twice as much as the originals.

2. **The K & E way**—Albanene tracing paper is made transparent with an inert synthetic resin which is chemically stable . . . can't leak out—ever!

   **Result:** Albanene stays transparent . . . stays strong . . . protects every nickel you invest in time and talent working on it.

   **Important:** During manufacture, constant testing *guarantees* uniformity as well as pencil taking and erasing qualities. The very qualities that have made Albanene—America's best selling tracing paper.

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Seattle • Montreal

KEEP INFORMED — NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

## Thermostat Control

Spencer Thermostat Div., Metals & Controls Corp., is introducing a new, miniature thermostat control ideal for original equipment manufacturers who are concerned with volume usage suitable for an engineered thermostat application. Applications include coffee percolators, table appliances, electronic equipment, heating apparatus and major appliances.

Identified as the Klixon 201 series, the control features factory preset temperature settings from 80 to 300 F, positive snap-action operation. Over center toggle mechanisms, magnets or complicated parts are completely eliminated by the firm's snap action disc. Contacts and disc are enclosed for protection, but can be exposed for faster thermal response where necessary. The unit can be mounted in any position. Terminals are solder type. Electrical ratings are 10 amps., resistive, 110 VAC, 6,000 cycles; 5 amps., resistive, 240 VAC, 50,000 cycles.

## Regulating Valve

A. W. Cash Co., Box 551, Decatur, Ill., has announced the addition of a new small size pressure reducing and regulating valve to the Cash Standard line of automatic valves, controllers, governors and regulators.

Designated Type 3381, the valve, which is $5^{5}/_{8}$ in. high and $2^{5}/_{8}$ in. face to face, provides control of air, water, oil, steam, and most liquids and gases. Body and trim are bronze, seat and diaphragm are bronze or composition. Sizes are $^{1}/_{4}$ and $^{3}/_{8}$ in. with screwed ends.

The valve can operate at inlet pressures as high as 400 psi at 150 F, and 250 psi at 400 F. Fire spring ranges are available from 5–300 psi delivery pressure. The valve can be supplied with a pressure gage, mounted in either of the two outlet connections. Adjusting screws are available with square head, plastic knob or wing nut.

## Temporary Anti-Rust Compound

Parts that must be stored temporarily can be rust proofed effectively and at low cost with an anti-rust compound developed by the International Chemical Co., Dept. 116, 2628 N. Mascher St., Philadelphia 33, Pa.,

Called NoRuSol, this water soluable compound is said to protect parts so that they can be stored indoors for 30 or more days under normal plant conditions. According to the manufacturer, in recent tests parts coated with the compound showed no evidence of rust after 400 hours exposure in a humidity cabinet with the temperature at 100 F and relative humidity of 100 per cent.

Normally used as a 3 per cent solution, the compound can be applied either by spraying or by dipping parts in the solution heated to 130 F. This protective film can be left on work for most subsequent operations. But in the few cases where it is necessary to have a chemically clean surface, the compound can be easily removed with a mild cleaning solution, the firm states.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
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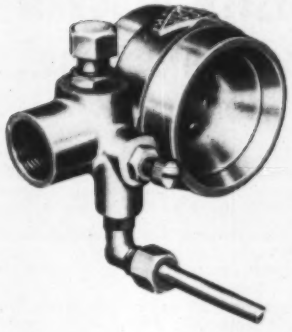
## O-Ring Compound

A new 90 durometer synthetic material has been developed by the Parker Rubber Products Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio. The material is for molded seals in service up to 300 F with MIL-L-7870A grease for lubricating aircraft instruments and MIL-L-6083 oil for preservative purposes in hydraulic equipment.

The new material, designated Parker O-ring compound 49-091, is also recommended for use with MIL-L-7808A and MIL-L-5606 oil up to 250 F.



## Hose Adapter

Development of a new line of LP-Gas hose adapters for use on engines up to 60 hp has just been announced by American Liquid Gas Corp., 1109 Santa Fe Ave., Los Angeles 21, Calif.

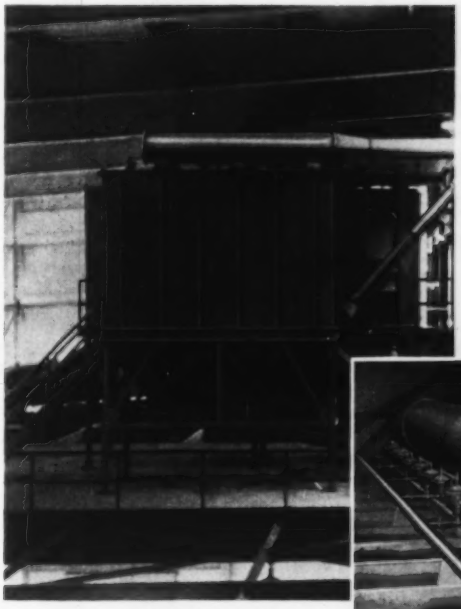
These units were designed to meet the demand for a simple and economical method of effecting LP-Gas conversions on engines which are not adaptable to spud-in type installations. They may be used for either vapor or liquid withdrawal conversions.

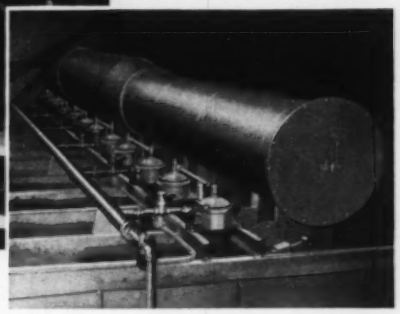
Designed primarily for use on tractors, fork-lifts and industrial trucks, the hose adapters may also be used on any type of internal combustion engine up to 60 hp, the company says.

The adapters are equipped with a power and idle adjustment. Venturis are the removable type and may be selected to fit the specific engine requirements. They are manufactured to fit the following ID hose sizes: $1^3/_{16}$, $1^1/_2$, $1^{13}/_{16}$ and $2^1/_8$ in.

Installation, which is made in the hose connecting the air cleaner and the carburetor, is very simple. All that is required is to remove the hose, cut a 1 in. section from it, insert the adapter and then reconnect the hose. For liquid withdrawal systems these adapters are used in connection with an Algas 1900-E converter. Vapor systems using this hose adapter employ the use of both a primary and secondary regulator such as an Algas Model 1000-4 and an Algas Model 880 or 1150.


# Norblo gives you continuous peak-load Dust Collection *through automatic bag cleaning*





Plants running full blast can ill-afford down time for equipment repairs and maintenance. Dust collection around the clock without interruption is commonplace with Norblo Automatic Bag Type Arresters.

Complete time-cycles for progressive automatic bag shaking are controlled by highly efficient electric timers. Only one compartment is cut out at a time, and that for just a few seconds, with *no* drop in efficiency for the installation as a whole. Norblo's compartment construction is the time-saving solution to inspection, maintenance and repair in busy plants . . . For "good housekeeping" or for salvage, Norblo Automatic installations have many design advantages wherever continuous high recovery of industrial dusts and fumes is important.

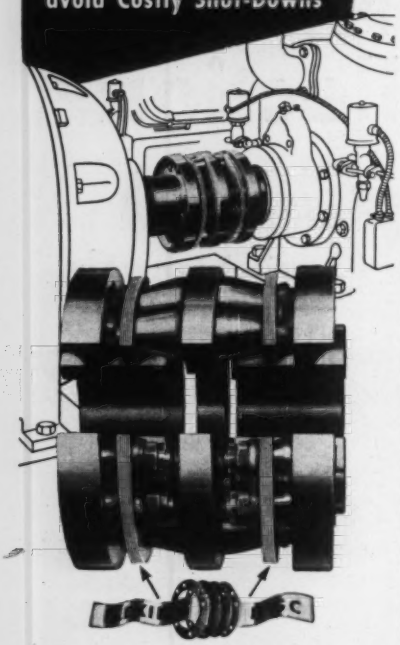
It pays you to write at once for latest information on Norblo Automatic Bag Type Dust Arrester that assures constant high efficiency dust handling.

**THE NORTHERN BLOWER COMPANY**

6421 Barberton Ave., Cleveland 2, Ohio OLympic 1-1300

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

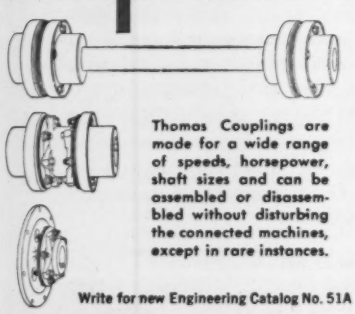
*Specify* THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



**Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.**

DISTINCTIVE ADVANTAGES

| FACTS | EXPLANATION |
|---|---|
| NO MAINTENANCE | Requires No Attention. Visual Inspection While Operating. |
| NO LUBRICATION | No Wearing Parts. Freedom from Shut-downs. |
| NO BACKLASH | No Loose Parts. All Parts Solidly Bolted. |
| CAN NOT "CREATE" THRUST | Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement. |
| PERMANENT TORSIONAL CHARACTERISTICS | Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained. |



**Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.**

Write for new Engineering Catalog No. 51A

**THOMAS FLEXIBLE COUPLING CO.**
**WARREN, PENNSYLVANIA, U.S.A.**


KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

## Hydraulic Pump

Baughman Mfg. Co., Jerseyville, Ill., has announced the introduction of a hydraulic pump for original equipment manufacturers.

The pump, designated Model HP-800, is a self-contained unit. The pump operates independently of other equipment. It is compact in design, requires only one hose line, running from pump to ram. The unit is available with either a 6 or 12 volt electric starting motor, which is mounted directly on housing that contains control valve, pump and reservoir.

Other features include positive ball-type valves, with all bearing and wearing surfaces bathed in oil.

## Die Steel

Heppenstall Co., 4260 Hatfield St., Pittsburgh, Pa., has created a new chromium-molybdenum-vanadium die steel called Moldtem, which it is now marketing in blocks and bars for plastic molds and zinc die casting dies.

According to the firm, the blocks and bars are prehardened and ready for use without further heat treatment. They are available in a range of standard cross sections, but orders for special sizes also can be filled. Hardness range is Brinell 302 to 341.

In announcing the availability of the new die steel, the company states that chemical composition and quality control procedure combined to give Moldtem maximum polishing characteristics and ease of machinability. The company is currently marketing the steel as specifically suitable for making closed dies for plastic injection or compression molds. It also has been found satisfactory for forming dies for zinc castings.

Although the new Moldtem is prehardened and generally requires no further heat treatment, the company indicates the new material, when desired, will take such superficial surface hardening as nitriding, carburizing and chrome plating.

## Crane Control

Stepless control for overhead electric traveling cranes has been developed by Harnischfeger Corp., Milwaukee 46, Wis., based on the principle of electronics, and using gas-filled tubes in the control circuit. The company says the new control scheme has greatly reduced the number of mechanical contactors.

Applied in conjunction with the firm's standard Magnetorque, electronic stepless control provides an infinite number of speed variations, on all motions. Also, hoisting and lowering speed are stabilized to a degree never before approached with any other type of a-c control scheme, resulting in an almost flat speed-torque curve, the company claims.

The new control also provides complete plugging protection so that motors may be reversed from the "full" position in one direction to the "full" position in the opposite direction, without danger of damage.


# ENGINEERS

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**SERVO ENGINEERS**
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**ELECTRONICS DIV.,**
**Milwaukee 2, Wis.**

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Seeks experienced engineers for the further development and systems testing of Inertial Guidance Systems and their Servo Loops.

Enjoy Challenging Opportunities in the most versatile Laboratories in the country. Work with the top men in the field and with the finest test, research and development facilities. We are in the process of a Major, Permanent, Expansion Program. New Plant facilities being added in suburban Milwaukee area.

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GM's Electronics Division aggressive position in the field of manufacture and GM's long-standing policy of decentralization creates individual opportunity and recognition for each Engineer hired.

**Recent EE,ME Graduate Inquiries Also Invited**

Milwaukee offers ideal family living in a progressive neighborly community in cool, southern Wisconsin where swimming, boating, big league baseball and every shopping and cultural advantage is yours for the taking.

To arrange personal, confidential interview in your locality send full facts about yourself today to

**Mr. John F. Heffinger**
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**Milwaukee 2, Wis.**

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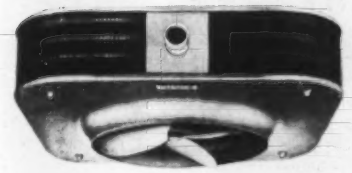


## Unit Heaters

Warren Webster & Co., Camden 5, N. J., has announced a newly-designed line of Little Giant unit heaters of the down-blow or horizontal-blow type. These are being offered in 34 models, ranging in capacity from 34,000 to 684,000 Btus (steam ratings) per hour, in Bulletin B-1730..

The unit heaters are of the draw-through type and utilize rectangular wrap-around heating elements. Since the elements are specifically designed to operate with either steam or hot water, there is a 50 per cent reduction in the quantity needed for a complete stock supply of the product line. Heating elements are constructed of copper tubing with extended corrugated-aluminum plate-type fins. Male pipe connections extend from square steel headers on opposite sides of the down-blow unit, permitting installation close to the ceiling and providing maximum headroom. The motor, which incorporates sealed, life-lubricated bearings or grease-lubricated ball bearings, can be removed through the fan outlet from below, without disturbing the installation.

Casings are of heavy-gage furniture steel, with a baked-on gray-green hammered finish. Motors are designed for continuous duty and are mounted to eliminate the transmission of motor noises to the unit casing. A continuous stream of air at room temperature is drawn over the motor during operation of the fan, which is designed for quiet operation and the handling of large volumes of air. Each unit is sound-rated in accordance with the new IUHA sound test code. Air deflector attachments are available in a wide variety.

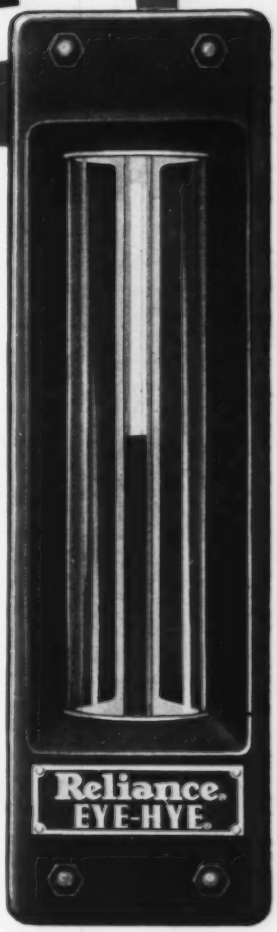
## Soft Rubber

Roth Rubber Co., 1860 S. 54th Ave., Chicago 50, Ill., has developed a new supersoft, non-porous rubber that can be securely bonded to metal called compound RRD-992. The firm's engineers believe this is to be the softest, solid rubber as yet developed by the industry.

This new rubber has a softness characteristic of 5 durometer, can be used in temperatures up to 200 F. It is a reasonably good electrical insulator and can be vulcanized or bonded to metal and other materials.

The company says the rubber (it is not a sponge) can be used to absorb vibration, dampen sound, or as an air-tight or water tight gasket. It is made in sheets or strips up to one in. thick, or the company will mold or bond it to metal or other odd shapes to meet the customer's needs.


Newly Styled—
Wide Vision, Simplified Face
EYE-HYE®

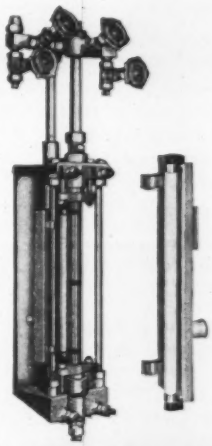



The Reliance Remote Reading Water Level Indicator

**Accurate "liquid column" reading visible from large area because of brilliantly illuminated green liquid and wide angle face plate.**

EYE-HYE is the original trouble-free manometric gage for dependable remote water level supervision. There's nothing new about its *operation*, but the new face plate and new illumination (fluorescent) make it easier to read all over the control room.

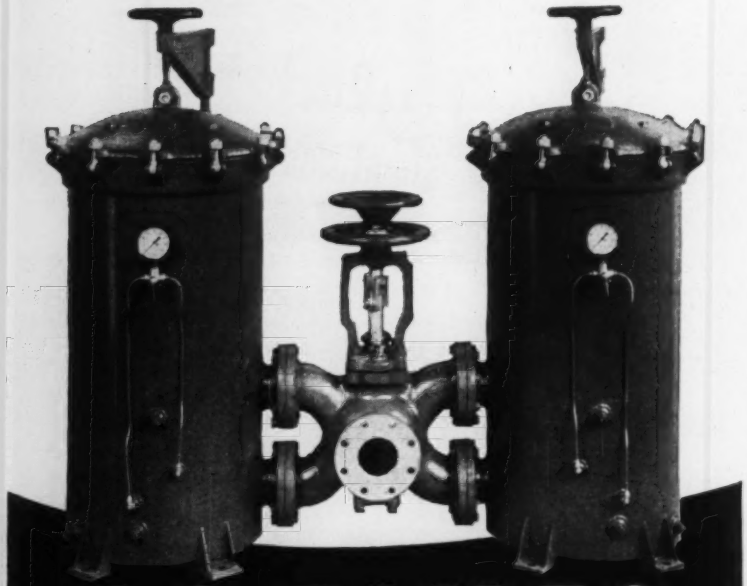
*Simplicity* is the secret of EYE-HYE's dependable full-range accuracy — no mechanical working parts — no adjustments on location. Supplementary alarms — lights or horns — can be added by equipping EYE-HYE with Reliance EA9-R Levalarm. Models for any remote gage need — any pressure. Write for Bulletin CO.



Fluorescent Illumination

Even lighting the entire length of the gage window is provided by a fluorescent tube. The fluorescent unit is available separately for installation in all but very old EYE-HYE models in use. Write for prices; mention the model number found on name plate.

THE RELIANCE GAUGE COLUMN CO.
5902 Carnegie Avenue, Cleveland 3, Ohio



20 TIMES
MORE FILTERING AREA

with NUGENT Duplex Lube Oil Filters

This new large capacity duplex full flow lube oil filter consists of two parallel filters with a flanged switching valve supported between them. Each filter is equipped with a three-way cock and differential pressure gauge and has a capacity of 225 GPM of 150 SSU viscosity lubricating oil at about 5 psi pressure drop. They may be operated independently or in parallel.

Nugent filters provide 20 times more filtering area than most other filters of comparable size. "Extended area" filtering is yours because Nugent utilizes a laminated crenulated fiber disc filter cartridge affording filtering action both through proximate discs and adjacent portions for maximum filtering capacity The duplex has a high flow rate at low pressure drop combined with extremely fine filtering absorption and neutralizing properties of a depth type filter.

A lifting mechanism facilitates cover removal and exchange of filter recharges which have a useful life 4 to 10 times that of other types and are expendable.

If you must filter fuel, lube oil or coolants, there is a Nugent filter to meet your requirements. Write for descriptive literature.

Wm. W. Nugent & Co., Inc.
3412 Cleveland St. Skokie, Illinois

Established 1897

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

## Gas Water Heater

An automatic gas water heater, designed specifically for heavy duty commercial and industrial installations where a corrosion resistant aluminum alloy tank is indicated as desirable for long rust-free service life, is now made by Ruud Mfg. Co., Kalamazoo, Mich.

The new Sanimaster gas water heater is available in two models. No. AST 90-168 operates on natural, mixed, or manufactured gas. The company says this unit is today's largest automatic storage gas water heater with a nonferrous tank, having 200,000 Btu input for a recovery rating of 168 gal of water raised 100 degrees in temperature per hour.

The companion model, No. AST 90-143 operates on LP-gas. A 170,000 Btu input gives a recovery of 143 gal of water raised 100 degrees in temperature per hour.

American Gas Association Laboratories has approved these gas water heaters as an automatic storage water heater, and as a circulating tank water heater. It can be installed singly or in multiples for single, or for self-contained two-temperature operation.

The firm suggests that the new heater, when water heating demand does not require an auxiliary storage tank, has desirable features for installation in restaurants, apartments, motels, schools, convents, industrial plants, and smaller institutions. Many of these, says the company, require two-temperature hot water.

As a circulating tank water heater, installed in conjunction with tanks containing from 100 to 3000 gal, the new water heater is said to be ideal for use in large schools, industrial plants, stadia, hospitals, etc., that involve high periodic hot water demands.

Within the 75 gal aluminum alloy tank in this new gas water heater are 8 flue tubes feeding into a 6-in. rear flue outlet; a boiler-type handhole cleanout, 1-in. cold water inlet and a 2-in. hot water outlet.

## Bench Mounted Air Press

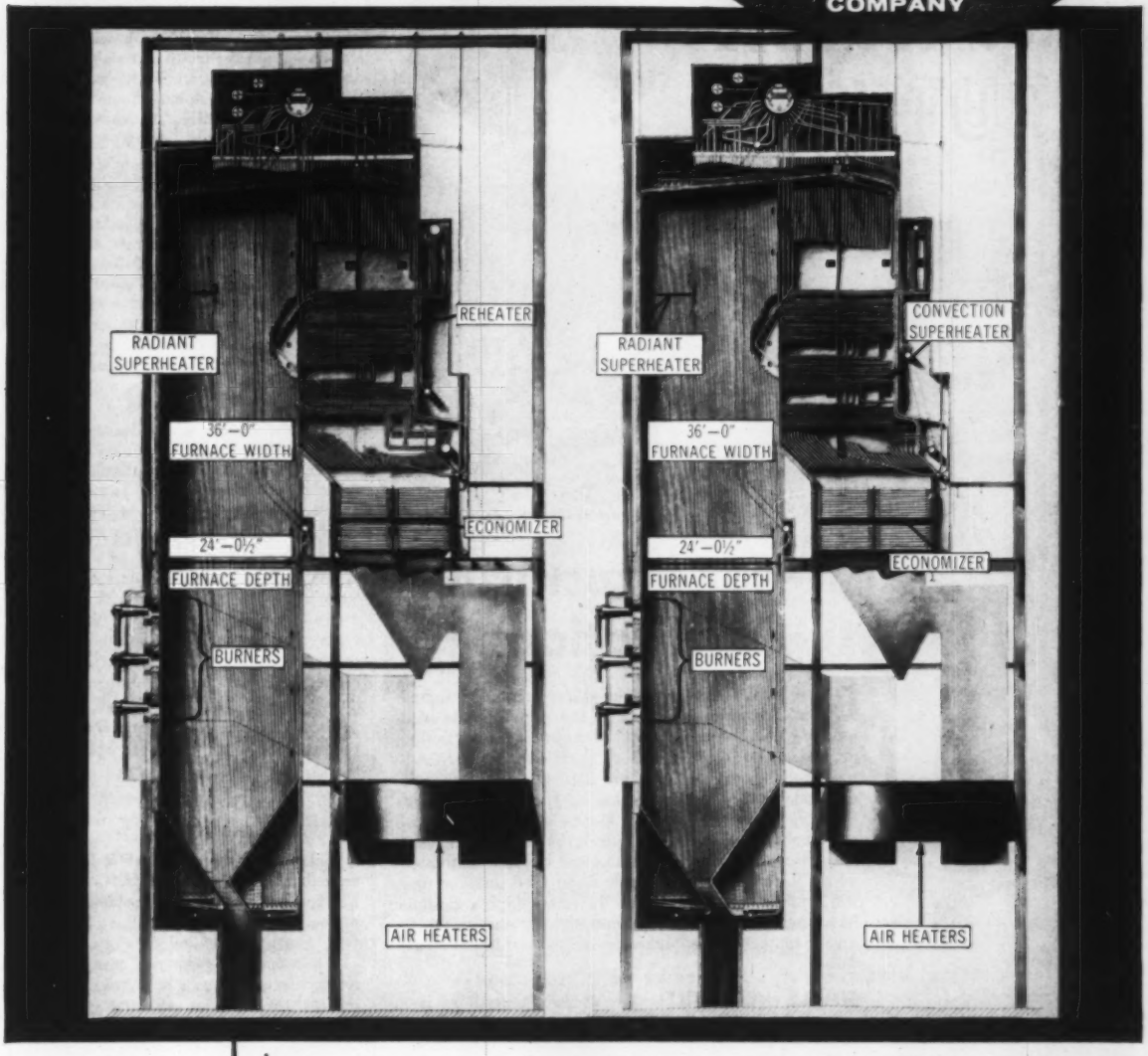
Carlson Co., 277 Broadway, New York 7, N. Y., announces an air press designed for spring manufacturing including looping, bending and coiling wire up to $^{3}/_{32}$ in. diam. The firm says the press can also be used in other industries for light punching, trimming, crimping and secondary operations at high speeds.

Over 1800 loops and 300 stampings per hour have been made, the company says. Speed depends on ability of operator to pick up part and place it in position. The press comes ready to use with bolster plate, foot switch, solenoid valves and all connections. A screw stop adjusts ram stroke up to 2 in. and a valve controls ram speed. The size is 10 × 10 × 18 in. high with a 6-in. opening, net weight 100 lb.

*Continued on Page 50*

# DIAMOND BLOWERS Selected for WORLD'S FIRST 2,000,000 POUND STEAM GENERATOR

**UNIT No. 3**
**RIVER ROUGE POWER PLANT**
**The DETROIT EDISON COMPANY**



**DIAMOND POWER SPECIALTY CORP.**
LANCASTER, OHIO
*Diamond Specialty Limited • Windsor, Ontario*

7451

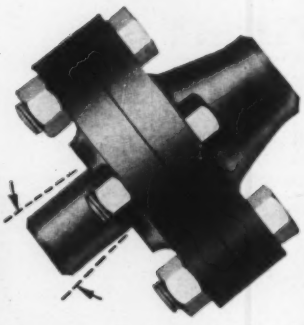
**When Unit No. 3 at the River Rouge Power Plant of The Detroit Edison Company goes into operation late in 1957, its 2,000,000 pounds-of-steam-per-hour Foster Wheeler steam generator will make it the largest in use. The design pressure is 2700 psi and the superheater outlet pressure is 2450 psi. Superheater outlet temperature is 1050 F and the reheater outlet temperature is 1000 F.**

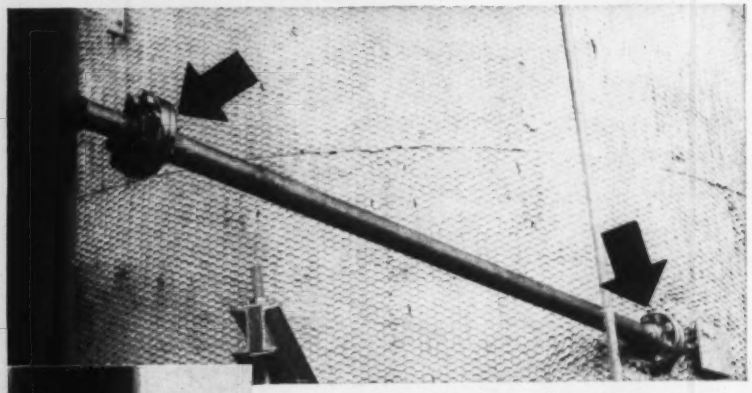
**Unit No. 3 is in effect two units operating side by side as one. Both furnaces are identical, each containing a radiant superheater in the front and side walls. All convection superheater surface is located in one and all reheater surface in the other.**

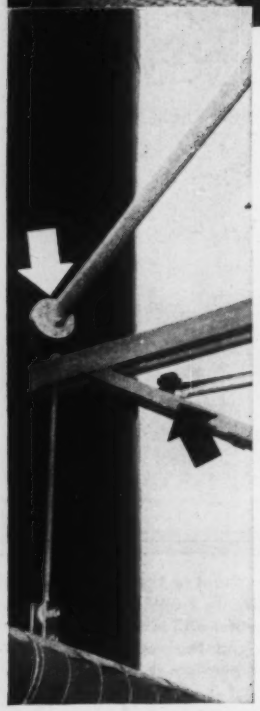
**Unit No. 3 will be cleaned by Diamond Blowers . . . new type Model IK long retracting blowers for the tube banks and Model IR short retracting blowers for the walls. The cleaning medium is compressed air and the electric motor driven blowers are automatically and sequentially controlled by a Diamond Selectromatic Panel.**

**This is another of the many outstanding installations for which Diamond Blowers have been selected.**

# HERE'S HOW
Power Engineers and Builders Use
# BARCO FLEXIBLE STRUT JOINTS







## —for Structural Applications

Barco Flexible Strut Joints have been designed and are produced to meet the requirements of a number of America's top engineering construction firms engaged in building power stations, nuclear reactors, and refineries. They are used in making flexible guy rods or tie rods for bracing large cooling lines, hot fluid lines, high temperature steam headers, high pressure turbine or pump inlet and outlet connections, and many tall, small diameter stacks and vessels. Although many Barco Strut Joints have been used in structural work for years, applications in latest piping designs have been accelerated enormously by the trend to higher temperatures, higher pressures, and larger structures.

**SIMPLE, VERSATILE!**—The Barco Strut Joint is a dependable, compact, versatile fitting requiring practically no maintenance. It is a simple ball and socket that provides a point of flexibility. The close fit between ball and casing, allows for reversible loads, not possible with pin and clevis type braces. Barco Strut Joints support without restricting freedom of movement.

**COMPLETE LINE**—Welding ends for field or shop use. Unique "Bar-Moly" treatment of wearing parts provides permanent dry lubrication for long service.

**ENGINEERING SERVICE**—Barco will be glad to work with your engineers in the selection of joints to meet your requirements. *Specifications and information on request.*

**Send for a copy of interesting, new technical data sheet No. 229 describing "BARCO FLEXIBLE STRUT JOINTS."**

**BARCO** *Manufacturing Co.*

**521H Hough Street** • **Barrington, Illinois**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## Bondized Cementable Sheets

"Bondized" Teflon sheets and tape specially treated on one or both sides to allow cementing to a variety of materials or to itself using commercially-available adhesives is available from Shamban Engineering Co., 11617 W. Jefferson Blvd., Culver City.

The sheets and tape can be cemented to steel, aluminum, wood, plastics, cardboard, etc., or rubber to provide unique combinations of advantages, the firm states, and the material has commercial, industrial, and defense applications in aircraft, automotive, electronic, food processing, baking, candy cartoning, and many other industries. Applications are said to be numerous for parts that encounter wear or corrosive conditions such as liners and coverings for tanks, jigs and fixtures, rollers, bushings, loading hooks, sliding surfaces, pipe, ducts, valve facings, and machine parts.

Tape is available, treated one or both sides, in thicknesses ranging from .005 to .125 in. up to 24 in. in width. Bondized sheet, treated one or both sides, is available in thicknesses from $^1/_{32}$ to $1^1/_2$ in. and 12-in. × 12-in. standard sheet sizes.

A coating on the surface of metals, plastics, or woods provides low friction corrosion and wear resistance along with self-lubrication, the company says. It has dielectric strength of more than 500 per mil, will not carbonize or burn. It resists abrasion and corrosive chemicals at high and low temperatures and is non-toxic.

Tensile strength of the material and aluminum is 600–650 psi. Peel strength is 35–40 lb-in.

## Torsional Calibrator

Model CA1050 torsional calibrator is announced by the MB Mfg. Co., Div. of Textron American, Inc., New Haven, Conn., as the latest addition to its line of vibration test, measurement, and control equipment.

While designed primarily as a calibrator for torsional pickups, rate gyros and similar devices, the torsional calibrator is also used for testing relays, checking torsional frequencies of small armatures, and exciting torsional modes of vibration in a wide variety of small rotating units.

The firm says the calibrator is capable of producing torsional oscillations without resonances in the moving element to frequencies as high as 1600 cps under free-table, no-load conditions. A generated torque of 110 ft-lb permits rotational acceleration up to 1570 radians per sec$^2$ with no table load. Maximum torsional displacement is 45 deg total between mechanical stops.

A signal generator attached directly to the table of the calibrator monitors angular velocity of the table motion to within 5 per cent of actual table velocity. The firm's Model M3 vibration meter may be used in conjunction with the signal generator; a simple conversion factor changes linear meter readings to rotational quantities.

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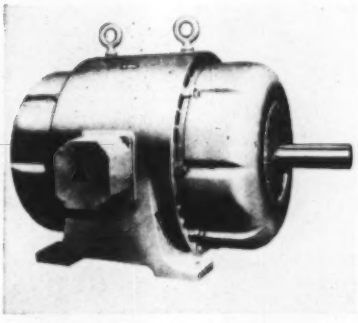
## Edgewise Panel Meter

Fullscale meter sensitivity of $^1/_2$ microampere—believed to be unique in the electrical measurements field—has been attained in an edgewise panel meter developed by the Greibach Instruments Corp., Metuchen, N. J. an associate of Gulton Industries, Inc. The new unit, designated Model 700, is the first of a complete series of edgewise panel instruments for voltage, current and resistance measurements.

All the firm's edgewise meters incorporate the bifilar suspension movement which minimizes friction losses and prevents damage even under high external stress. The units are characterized by features such as high overload capacity, relatively small energy input, and accuracies up to .25 per cent.



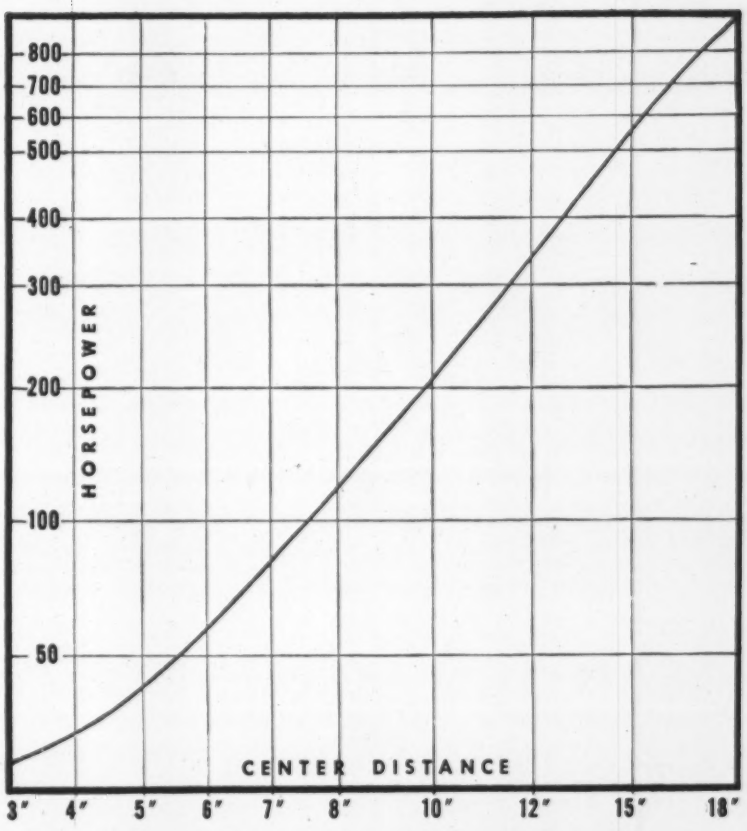
## Fan-Cooled Motor

A new type of totally-enclosed, fan-cooled motor in the size range from 50 to 200 hp, featuring a unique double-end ventilation system has been announced by Delco Products Div., General Motors Corp., Dayton, Ohio.

The new design employs two external cooling fans, one at each end, which draw cool, fresh air directly across each bearing, then drive it the length of the motor through large cooling tunnels cast in the walls of the main frame. The fans are designed to direct the air onto the bearing housing with considerable force, scrubbing away heat and maintaining uniformly cool bearing temperatures. The large, non-clogging tunnels, being integral with the frame walls, provide efficient heat transfer to the air stream, the company says. In addition, each tunnel has a longitudinal fin to smooth out air flow and provide extra radiating surface.

Each fan handles only half the air volume required, and since air passages are generous in size, the new motor is said to be notably quiet in operation. A deflector at the end of each air passage directs the discharge air away from the cool air intake.

Slot cell insulation is Mylar, bonded to high quality electrical paper. The stator, after winding, is insulated with exclusive Delcote insulation, a combination of high-quality insulating varnish and cotton fiber flock which penetrates every space in the winding,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. . . because we think the load-carrying capacity of Cone-Drive speed reducers is pretty impressive all by itself. Then, we've also got a lot of friends in the worm gear speed reducer business. And they make pretty fair reducers themselves.

Two things are responsible for the high capacity of Cone-Drive speed reducers. First, we use extra-heavy gears mounted on oversize taper roller bearings in reinforced, heavy housings. Extra "beef' alone accounts for part of our capacity.

Even more important, however, is the Cone-Drive double-enveloping worm gear design. Here, we literally wrap worm and gear around each other to put ⅛ of all teeth in continuous full-depth contact. This results in spreading tooth contact over a greater area, reducing pressure on individual teeth, increasing load capacity and life of the gearing.

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Cecil Young, Chief Engineer, The Peerless Electric Company, with Peerless motors in new NEMA frame sizes.

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Peerless is one of the few fan and blower manufacturers that builds its own motors. That's one reason why Peerless fans and blowers conform with all standards—PFMA, NAFM and NEMA. What's more, because we build our own motors, we can match them to fans and blowers for peak performance.

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**Premium-built** Peerless motors power famous OEM products in all fields and are the choice of those manufacturers who insist on specials rather than repetitive models. Is it any wonder that Peerless Electric fans and blowers hit such high performance levels.

Select the fans and blowers that meet all industry codes —Peerless. Check the Peerless bulletins. SDA-160 shows performance data on all fans and forward curve blowers. SDA-200 gives complete data on backward curve blowers. Dimension prints available on request.

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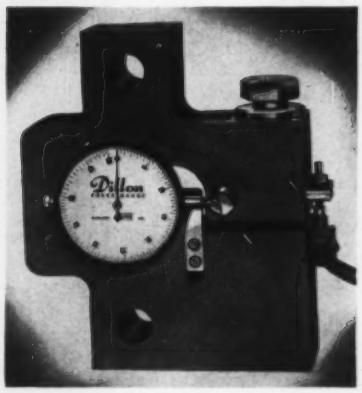
seals off the slots completely from dirt and moisture and gives the stator exceptionally high moisture and abrasion resistance and mechanical strength.

Bearings are open type with provision for regreasing and pressure relief without removing any part of the motor, should such servicing be desired. Bearings and bearing housings are remeasured after manufacture and selectively mated to provide extremely accurate fit.

The new motor is available in a wide range of speeds in ratings from 50 to 200 hp, with larger sizes on special order.




## Force Gage

W. C. Dillon & Company, Van Nuys, Calif., is now producing an 0—50,000 version of its force gage, for a variety of testing applications of the high range.

The instrument is available for either compressive or tensile tests and has a warranted accuracy of within 1 per cent of the indicated reading. The new 50,000 lb model is a compact instrument. Dimensions of the compression model are height $5\frac{1}{2}$ in., thickness (including dial indicator) $3\frac{1}{2}$ in., width 8 in., with a net weight of 30 lb. Tensile model dimensions are height 10 in., thickness $3\frac{1}{2}$ in. (including dial indicator); width 8 in., with a net weight of 37 lb.

Model pictured is the tensile version, with eyes for the insertion of clevises. Compression model has instead a recessed cup on top for seating a free-riding, hardened steel ball. Rotating action of this ball under pressure insures true vertical thrust against gage.

Safety stop-bolt at upper right of illustrated tensile model prevents undue expansion of open end of gage. Bolt, of heat treated alloy steel, screws into lower portion of gage while allowing upper portion to ride free. Accidental overloads beyond the gage's normal 25 per cent safety factor merely cause the upper portion of the gage to come to a positive stop against the bolt head.

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## Quad Actuator

Built to operate high-pressure plug and ball valves up to 36 in. in size is a quad actuator introduced by Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif.

Features claimed for the new quad actuator are balanced torque delivered to valve stem through four-cylinder operation; gas and oil systems entirely separate; no gas-oil interface; for periodic testing, detachable lever permits operation of actuator and controls without turning main valve; easy field installation without modification of plug valve; available in wide range of torque capacities, with a variety of control systems.

Complete details and specifications are contained in Bulletin 3022, available from the company.

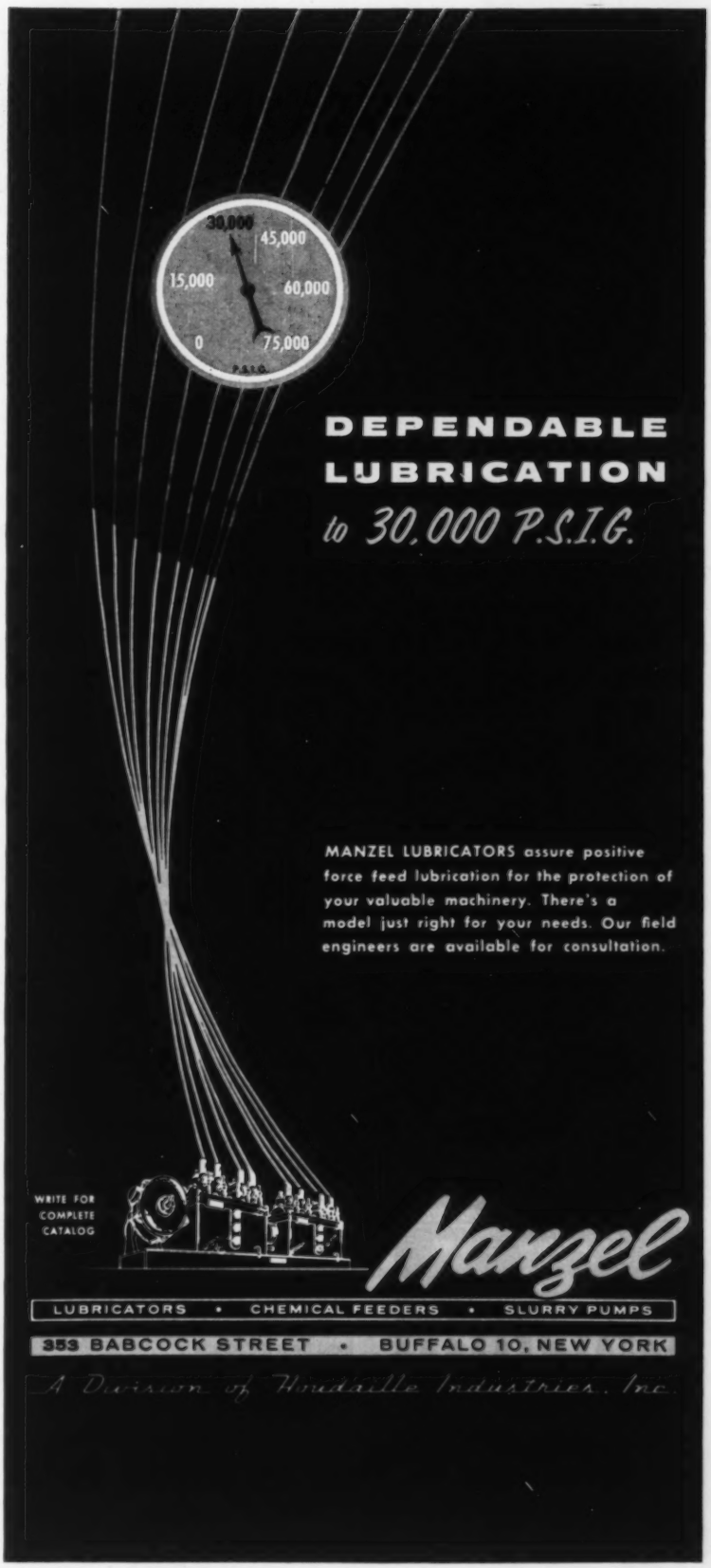
## Noiseless Hand Torch

A noiseless hand torch, light in weight, which is said to be the hottest low pressure gas-oxy hand torch yet made, has been developed by Bethlehem Apparatus Co., Inc., Hellertown, Pa. The firm says the unit is expected to be especially useful for the glass working trade, and will also have application in metalworking for the rapid heating of localized areas and in silver soldering, brazing, bending, and tempering operations. As a general laboratory tool, it will be useful for crucible ignitions and ore fusions, the company states.

Known as the Polymix torch, the new device can be held and applied with one hand where needed on the glass lathe. According to the company, accurate control of flame is possible through two valves under the operator's hand, and the flame may be changed at will from a small sharp flame of one or two in. to a wide, bushy, flame covering a large area of glass surface. Maximum length of flame is 18 in. with the entire flame area being dense blue in color.

The company says the new torch can operate on fuel gas at pressures as low as $^1/_4$ lb without requiring a booster. Designed to operate on 5–6 in. water column (normal city gas pressure) and low oxygen pressure, this torch readily works hard glass tubing up to 100 mm. With hydrogen, natural gas, mixed gas, propane or butane plus oxygen, the torch also readily works other hard glass used for laboratory apparatus and quartz.

The manufacturer states that flame is noiseless at all settings throughout a wide range of flame control. Silence and heat volume is due to a thorough mixture of the gases and complete elimination of turbulence. This thorough gas mixture is obtained by the intimate grouping of the gas and oxygen outlets in a compact area. More than 140 orifices are clustered in an area of less than $^{13}/_{16}$ in. diam. Turbulence is eliminated by the use of exceedingly small head outlets, thus producing a true viscous flow. Oxygen is fed through more than 70 capillary tubes, and the gas and oxygen unite entirely outside the burner head.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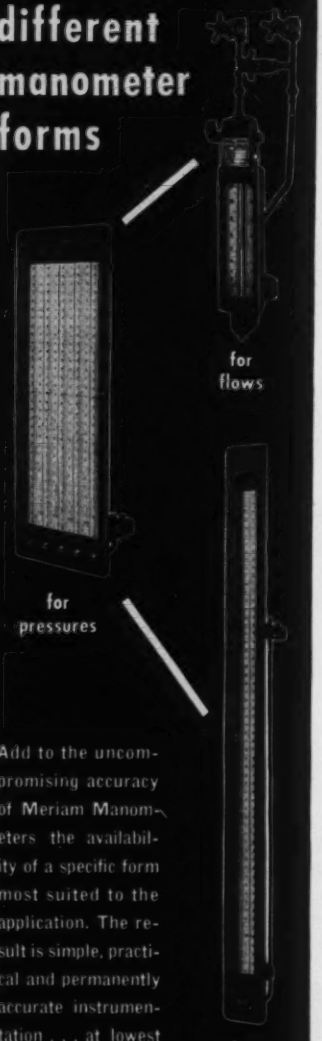


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## Aluminum Jacketing

A new deep-corrugated aluminum jacketing for tanks, towers and vessels has been introduced by Childers Mfg. Co., 3620 W. 11th. St., Houston, Tex.

The company says the addition of this jacketing for tanks, towers, and vessels, now makes it possible to do an all-aluminum jacketing job on any installation. Appearance is improved, and installation costs are cut because of lower first cost and ease of cutting and handling, the firm states. The jacketing may be attached with aluminum strapping and seals, or with aluminum sheet metal screws.

It is available with $1^1/_4$ or $2^1/_2$ in. corrugations. Rigidity is increased by cross crimping the aluminum before adding the deep corrugations. Cross crimping adds up to 97 per cent greater strength over plain corrugated aluminum, the company says.

A new factory-applied moisture barrier, added to corrugated jacketing, has been developed to eliminate corrosion of the jacketing from within.

## Refrigeration Parts

The marketing of a new aluminum coil-accumulator and connector assembly for refrigeration manufacturers is announced by Wolverine Tube Div. of Calumet & Hecla, Inc., Detroit 26, Mich.

This tubular assembly includes an aluminum accumulator, a bunch-type aluminum coil and aluminum-to-copper connectors. Specifically designed for an evaporator unit, the new assembly is said to simplify material handling and short-cut welding and assembly installations. Major applications for the assembly are in home freezers and domestic refrigeration units.

## Industrial Truck

A new 2000-lb capacity industrial truck features powered directional controls mounted on the steering column within reach of the operator's fingertips while both his hands remain on the steering wheel. The new Model B-224 truck, manufactured by Lamson Mobilift, Inc., Portland, Ore., is powered by gasoline or LP-gas.

The direction control lever mounted on the steering column in the same place the directional signal is located in a passenger car is teamed with an automatic transmission. The company says an operator can make smooth starts or reverse direction without clutching, gear shifting or removing either hand from the wheel.

The new unit turns within a radius of 67 in., can make a right angle turn in an aisle only $79^3/_4$ in., wide plus load size. The truck is $40^1/_4$ in. wide, $67^1/_8$ in. long (less forks).

Powered with a 32 hp Hercules engine, the truck operates up to 11.5 mph; lift speed loaded is 58 fpm. Double acting hydraulic cylinders control tilt forward 3 deg, back 10 deg.

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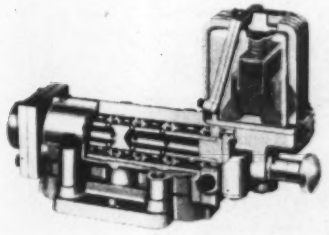
## Momentary Contact Switch

A single-circuit momentary-contact switch featuring a normally "on" position is available from McGill Mfg. Co., Inc., Electrical Div., Valparaiso, Ind. It is especially recommended by the company for automatic control of lights, as in door openings.

Switch No. 29 is rated for 0.75 amp at 125 volts in a-c circuits. It has a molded-phenolic case and nickel-finished metal parts. Wiring into circuits is simplified by use of 6-in. wire leads permanently attached to the switch. Dimensions are: $\frac{1}{2}$ in. wide, $\frac{1}{2}$ in. thick, and 1 in. long. Stem has a $\frac{15}{32}$ in. diameter and a $\frac{9}{32}$-in. length. It is UL inspected and approved.



## Control Valves

C. B. Hunt & Son, Inc., Salem, Ohio, introduced a new line, known as "B"-Type valves, said to offer many new features never before available.

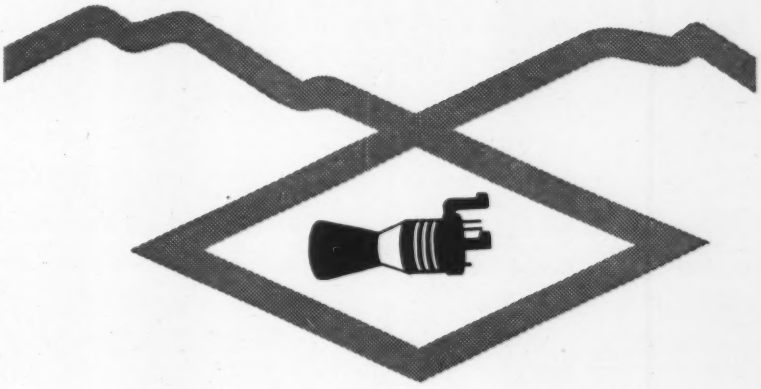
Valve chambers of the new valves (see cutaway view above) are formed by aluminum spacers held in accurate metal to metal end abutment. The company says this patented arrangement greatly simplifies internal construction and permits the O-rings or U-packers to be supported on both the inside and outside diameters without placing any mechanical pressure on the packers.

The hollow, radially ported, stainless steel, ground and polished plunger is the only moving part except the operating mechanism. Flow is from the inlet chamber through the radial ports of the hollow plunger and out through other ports in the plunger to the connected line. The firm states there is no direct impingement of flow across the packing, no lapped joints, and no metal to metal seating. All parts are in pressure balance eliminating any tendency to creep or crawl.

The sub-base mounting furnished with all "B"-Type valves permits the piping to be connected to the sub-base so the valve can be removed for inspection or repair without disconnecting the piping. Dual exhaust in four-way valves permits the speed of the operated piston to be controlled by installing adjustable exhaust plugs in the valve sub-base.

The solenoid operated valves are conservatively rated at 600 cycles per minute for continuous operation on air at pressures from 40 to 150 psi they can be operated at much


# GOOD NEWS FOR TURBINE SPECIALISTS



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**Thermodynamicists**—To analyze and develop high speed, subsonic and supersonic turbines. Aircraft jet engine or industrial steam turbine experience desired.

**Turbomachinery Engineers**—To work on the analysis, design and development of high speed rotating machinery. Openings are available for specialists in Gearing, Bearings, Rotating Seals, Subsonic and Supersonic Turbines, Centrifugal and Axial Flow Pumps and related mechanical activities.

**Analytical and Experimental Development Engineers**—With background in Thermodynamics, Aerodynamics, or Hydrodynamics, to work on subsonic and supersonic turbines, radial and axial flow pumps and other problems associated with high speed rotating machinery.

**Engineers**—Mechanical and Aerodynamic Engineers with experience on compressors, turbines, high speed axial flow and centrifugal pumps for analysis, design and experimental development work on high speed turbomachinery.

**General Mechanical Design** of components of high speed rotating machinery such as gears, bearings, rotating seals, hydraulic drives and transmissions, turbines and pumps.

**Hydrodynamicists** for analytical and experimental development work on centrifugal and axial flow pumps.

**Aerodynamicists and Thermodynamicists** for analytical and experimental development work on high speed subsonic and supersonic turbines.

**Stress Analysts** with experience on high speed turbomachinery. Background in gas turbine and jet engines preferred.

**Write Mr. A. W. Jamieson, Rocketdyne Engineering Personnel, Dept. 596 ME, 6633 Canoga Ave., Canoga Park, Calif.**

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# Engineers

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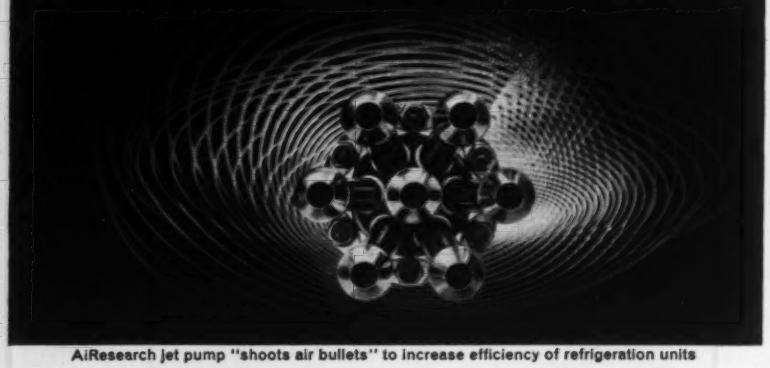

AiResearch jet pump "shoots air bullets" to increase efficiency of refrigeration units

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higher speeds for intermittent duty on air at 80 psi to 100 psi. Exterior feed type valves can be used in hydraulic service at pressures up to 250 psi using air for the pilot medium. Interior feed type valves can be used on oil from 40 to 150 psi at somewhat lower cycling speeds.

The bottom plate of the solenoid is positioned over steel dowel pins fitted with O-rings and is held in place with a spring. This cushioned shock resistant mounting reduces destructive hammering and vibration and greatly increases solenoid life, the firm says. The gasketed die-cast water-tight aluminum solenoid cover is split for easy accessibility, finned for cooling and fitted with captive screws and retaining chain.

The solenoid valves are of pilot operated design. An override button permits manual operation of the valve during installation or in case of power failure. The valves are available in single and double solenoid, also lever and single and double piloted designs.

### Powdered Metal Mill

A powdered metal rolling mill has been developed by Stanat Mfg. Co., Inc., 47-28 37th St., Long Island City, N. Y.

The machine, designated model FH-400, has 6-in. diameter × 6-in. face width chrome-vanadium alloy steel cold rolls, arranged horizontally, which turn on cage-type needle roller bearings; end thrust is taken by radial ball bearings. Designed to withstand great compacting pressures, each roll neck bearing has a load capacity of 25,000 lb equal to a maximum roll separating force capacity of 50,000 lb. An additional set of chrome-moly-tungsten alloy steel hot rolls may also be furnished if the mill application calls for work at elevated temperatures.

To obtain internal heating, such hot rolls may be fitted with cartridge elements, including slip rings and brushes to feed electric current to the cartridges, which heat the rolls. Two mill housings cast of high strength semi-steel minimize deflection and take loads in excess of usual requirements. Cross sectional area of the four mill posts is 48 sq in.

Roll adjustment is made by means of a single handwheel, worm gear screwdown provided with lifting studs which permit positive control of the roll setting in either direction. A graduated dial provides micrometer adjustment of the roll setting, and a clutch is provided to aid in establishing perfect roll parallelism.

The machine base and roll housing mounting plate are of welded steel construction with provision to permit material to pass beneath the rolls and through an independently installed sintering furnace. Close control of resulting strip widths is obtained by a set of precisely machined stainless steel side guides.

The unit is powered by a 5 hp, brake-equipped four-speed gearshift drive to operate at speeds of 10/20/30/40 rpm and is controlled by forward and reversing magnetic starters with overload protection actuated by

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NEW EQUIPMENT
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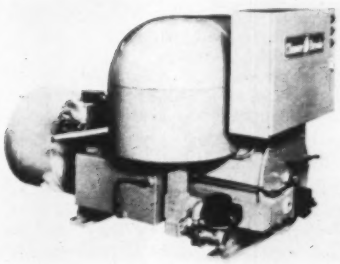
remote control push button stations mounted on both sides of the mill base. Emergency stop panels are located on the front and rear of the machine.

In recent performance tests, the unit successfully produced strip from such powders as copper, brass, nickel, nickel-silver, aluminum, molybedenum, tantalum, stainless steel and other ferrous alloys, the company announces.



## Gun-Type Burner

A new air atomizing burner designed to burn No. 6 oil, is being offered by Cleaver-Brooks Co., Milwaukee 12, Wis.

Acclaimed by the company as a great forward step in modern burner design, this new 90 gph burner introduces a new method of burning residual oils that obsoletes previous methods. The firm says the new design is the first burner of its type ever developed for burning No. 6 oil.

Air and oil are metered in the proper ratio at all capacities to assure maximum efficiency. Oil is finely atomized so that it burns easily and completely. Positive acting metering pump gives measured delivery of oil. Once the burner is set for the most efficient combustion it remains at that point indefinitely.

The company says low fire start assures safe, smooth ignition and prevents puff. Burner does not start at full capacity but begins with a small flame which is gradually built up to the required size. The shape of the flame is adjusted for the type of boiler it is to be used with.

Motor start is delayed until the oil at the nozzle is heated. The burner is instantly sensitive to heat demands, and provides steady heat for power loads and heating. The burner is as easy to install as a domestic burner, the firm states. It is a complete package, completely wired and ready for service lines.

## Flow Volume Control

Hays Mfg., Co., Dept. 219-A, West 12th St., Erie, Pa., announces a new flow volume control to deliver a large volume of hot or cold water at one set rate of fluid flow regardless of inlet pressures. Flow rates from 8 to 22 gpm are handled by this control. Flow volume data and product specifications are available from the company.

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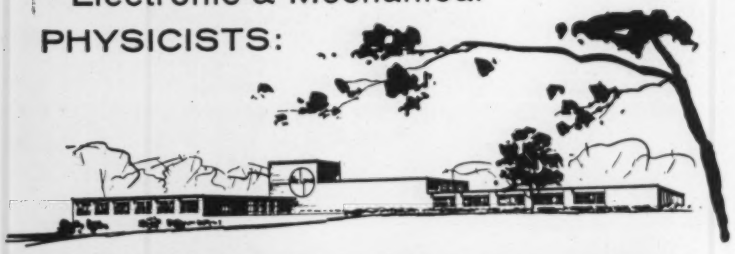

# Top Grade Openings

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Due to our continuing expansion program, a number of top grade openings exist in our new laboratories suburban to Washington, D.C. We urge you to consider the following:

1. At Melpar the engineer is not tied to a pre-arranged schedule of advancement. Instead, promotion and advancement are based on *individual recognition*, where skill and ability are the paramount factors of determination.

2. Melpar has doubled in size every 18 months for the past 10 years. New openings occur constantly. This enables the engineer to advance to positions of increased responsibility *as soon as he is ready*.

3. Our unique "project team" basis of organization gives the engineer an opportunity to participate in *entire* problems from conception to completion of prototype, and thus experience the "over-all" approach to engineering problems necessary to eventual directorship responsibility.

4. Our new air-conditioned laboratories encompass over 285,000 square feet and offer *complete* facilities for creative research and design. In addition to our central Model Shop, supplementary facilities, personnel and test equipment are available for *immediate* use within each project group.

5. The Northern Virginia Area, suburban to Washington, D. C., in which Melpar is located, offers excellent living conditions, enjoys the Nation's highest per capita income, fine homes and schools. Recreational, cultural and educational facilities abound. Fully-accredited graduate courses are offered at the Melpar laboratories and at 5 universities in the Area.

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### Industrial Water Softener

A special line of water softeners has been developed by Elgin Softener Corp., Elgin, Ill., to meet the soft water requirements of small businesses. The firm's "Double-Check" design, which is said to give up to 44 per cent more water softening capacity and which prevents loss of zeolite, is standard on the new units, along with a multiport valve, bell alarm meter and brine tank.

The special meter is wired to ring when a predetermined gallonage of water passes through. Capacities range from 28,000 to 91,000 grains with synthetic gel zeolite, and from 54,000 to 180,000 grains when resinous ion exchanger is used. Softener tank sizes are 10 × 54, 12 × 54, 16 × 54 and 18 × 54 in.

### 2-Amplifier Oscilloscope

A low frequency oscilloscope, Model 130A, one of two scopes recently announced by the Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., has nearly identical horizontal and vertical amplifiers.

The firm says the ampliers provide a maximum sensitivity of 1 millivolt/cm or 10 millivolts full scale deflection with pass bands from dc to 300 kc, and can accept balanced inputs on the five most sensitive ranges. The manufacturer states that the balanced inputs are most useful in industrial, medical and other applications where balanced low level signals come directly from transducers. The amplifiers also accept single ended inputs either ac or dc coupled. Conservative design, regulated power supply and precision components promote stability, increase reliability and virtually eliminate adjustment during operation.

The Model 130A sweep circuit employs a linear Miller-integrator triggered sweep instead of the relaxation oscillator or bootstrap types normally found in its price range; producing an accurate calibrated sweep, from 1 μsec/cm to 15 seconds/cm. Etched circuitry is used extensively.

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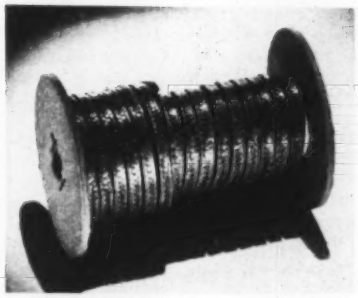


## Chemical Packing

A newly developed fiber used in 405 mechanical packing is said to offer greater corrosive resistance and service life by the manufacturer, Abbott & Biddle, 2417-X66-Federal St., Philadelphia 46, Pa. This packing is a braid over braid of glass and Teflon—two of the most inert fibers.

The fine pure Teflon fibers braided over a core of glass fibers and impregnated with Teflon presents a soft pliable low friction packing that is excellent for use on centrifugal as well as reciprocating and static applications, the company says. It is said to give excellent performance under wide environmental conditions of temperature and chemical exposure. Concentrated acids such as sulphuric, nitric, sodium hydroxide, aqua regia; alkalies, and practically all solvents simple or complex are easily handled.

## Multiple Tube Collector

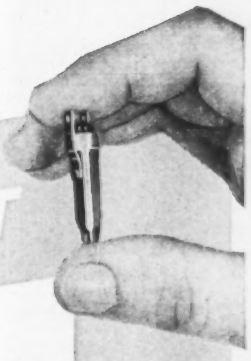
A mechanical collector of the multiple tube type incorporating new design principles to increase the gas handling capacity has been announced by Research-Cottrell, Inc., Bound Brook, N. J.

Designated the "Cyclo-trell," the new design has a higher collection efficiency and a greater gas flow for a given pressure drop than has been previously obtainable in conventional multiple tube collectors, according to the firm. The greater capacity, the company says, means fewer tubes per unit are needed, resulting in a lower total cost for a given capacity and efficiency.

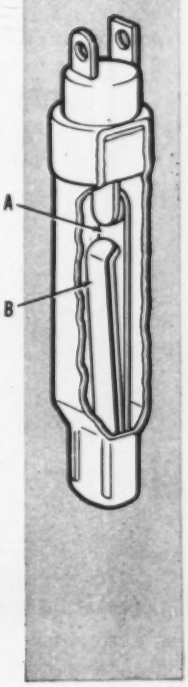
The unit consists of a series of cyclone tubes arranged in parallel, and depends on centrifugal force for its operation. The incoming gas enters the chamber under pressure, and flows into the lower set of inlet tubes which are attached to the lower header plate and are of slightly larger diameter than the upper outlet tubes. Specially designed inlet vanes at the mouth of the inlet tubes set up a circular motion in the gas so that suspended particles are forced downward and outward against the wall of the inlet tube. Cleaned gas is first forced toward the center of the collector tube and then upward and into the outlet tube by the pressure differential.

The company says a unique engineering feature is the design of the aerodynamically shaped inlet vanes which provide a faster and smoother gas flow. The purpose of the inlet


HOW CHACE THERMOSTATIC BIMETAL ACTUATES the FASCOSTAT



A Product of Fasco Industries, Inc. Rochester, N.Y.




The diminutive Fascostat, manufactured by Fasco Industries, Inc., is used in one of its application s as a motor protector in shaded pole motors for air conditioning equipment, furnaces, etc. Normally closed, the thermostat is calibrated to open when an unusual condition causes the motor to overheat. Of course, the Fascostat is dependent on its Chace Thermostatic Bimetal element for positive operation and continued accuracy.

Here's how it works: the current is carried by the spring arm (A) through normally closed contacts. Adjacent to the spring is the Chace Thermostatic Bimetal element (B). When the motor overheats above 235° plus or minus 5°F, the thermostatic bimetal deflects against the spring, opening the contacts and breaking the circuit. The motor begins to cool until the bimetal closes the contacts. This cycle will repeat until the fault is corrected.

**Chace Thermostatic Bimetal is manufactured in 29 types, in strip, coil or completed elements fabricated to your specifications. If your device is actuated by temperature change, write for our *new* 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal, formulas, calculations and other engineering data.**

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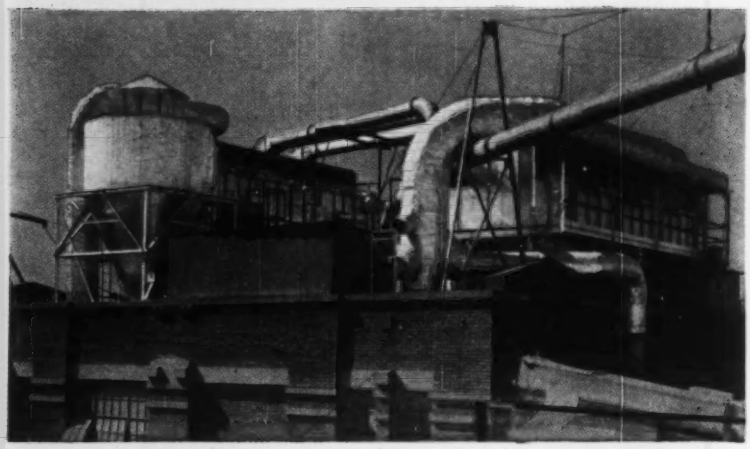
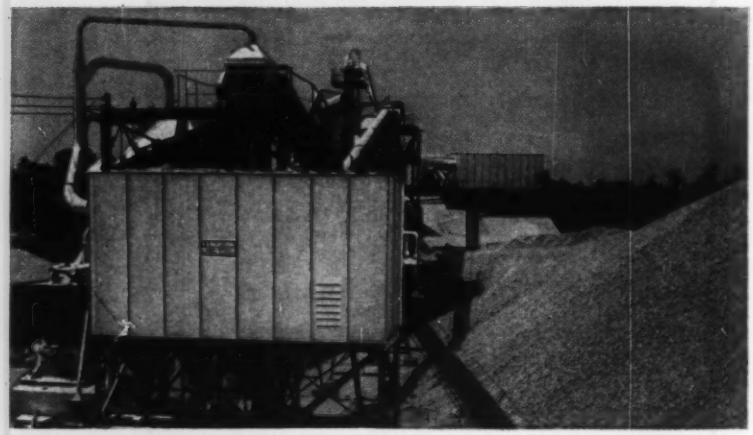
# GRAIN . . .



**KELLOGG COMPANY,** Battle Creek, Mich., saves $1,400 a *day* with Pangborn Dust Control! That's the value of the 35 tons of cereal "dust" salvaged every 24-hour day. In addition, Pangborn Cloth Screen Collectors keep Kellogg's buildings spotless, reduce machinery maintenance and have made working conditions safe and comfortable for employees.

# *or* GRANITE . . .



**H. E. FLETCHER CO.,** West Chelmsford, Mass., produces a wide variety of granite products. When Fletcher recently expanded plant operations, the firm installed Pangborn Cloth Screen Dust Collectors on the recommendation of an already-satisfied user of Pangborn Dust Control. Today costs at Fletcher have been cut in three ways; salvaged dust is sold to another firm, machine life is lengthened by reducing dust damage, plant housekeeping is cheaper.

# Pangborn CONTROLS DUST

Pangborn can solve *your* dust problem. Pangborn engineers will be glad to show you how Pangborn Dry or Wet Dust Collectors can save you time, trouble and money! See how Pangborn benefits varied industries. Write for free copy of "Out of the Realm of Dust." PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment.*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vanes is to start a fast spiral of incoming gas with a minimum of turbulence. The faster the gases spin the greater the centrifugal force on the suspended dust in the gas stream. "Drop out" and collection efficiency are higher as this centrifugal force is increased. The use of the aerodynamically shaped vanes, developed after extensive experimentation, minimizes gas turbulence and increases the centrifugal force, the firm states.

The outlet vanes serve the function of recovering energy in the outlet tube, thus increasing the capacity of the tube. This results in fewer tubes per unit. The vanes are positioned below the tube to decrease entry losses at the tube.

The shell and hopper of the unit are of 7-gage bolted steel construction, with cast iron inlet tubes and vanes to resist the abrasive force of incoming gas.

## Gear Assemblies

Anti-backlash gear assemblies have been announced as a standard stock item by Dynamic Gear Co., Inc., Amityville, N. Y. Pitch diameters range from 1 to 2 in., and they are available in $14\frac{1}{2}$ or 20 deg pressure angles and in 48-64-72-80-96- or 120 diam. pitch.

Hubs are of 303 stainless steel and manufactured as clamp type and solid type. Available bore sizes are .125, .1875 and .250 with a plus .0005 tolerance. Face thickness is $\frac{1}{8}$ in.

Gear blanks are 24ST aluminum with choice of alodine or anodize. All blanks are centerless ground to insure maximum parallism. Gears are cut to precision class I tolerance. Ask for supplement "C" to our General Catalog D-64.

## Hot Gas Measurement

A pyrometry instrument for measuring the temperature of hot gases in difficult situations where the gas temperatures and surroundings are constantly changing, has been introduced by Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.

The instrument, called a Land suction pyrometer, provides accurate measurement of heated gas from 0 F to 2900 F. The firm says the unit will find wide usage in water tube boiler furnaces; uptakes and regenerators of open hearth furnaces; glass tanks; and other industrial and laboratory applications.

Suitable indicating and recording instruments can be used in conjunction with the suction pyrometer, and the company will provide complete systems wherever required. Three models are offered using platinum and platinum rhodium sensing elements, each designed for a particular application and temperature range.

In operation, the device forces hot gases at high velocity past thermocouple temperature-sensing elements, in order to increase the conventive heat transfer from the gas. Con-

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centric shields of special design are employed to protect the temperature-sensing elements from disturbing external influences.

The main unit consists of a water-cooled stainless steel jacket, which is 6 ft in length.

The company says it will supply any length from 4 to 12 ft. A platinum thermocouple with 5 ft of spare wire in a reel box is also part of the suction pyrometer.

## Angle Socket

A new angle socket has been designed and is being manufactured by the Cleveland Metal Specialties Co., 1783 E. 21st St., Cleveland 14, Ohio., for use in electrical and electronic units in conjunction with printed circuits.

The angle socket provides for the mounting of tubes in units where there is limited height, and for maintenance and servicing accessibility where circuit boards are plugged vertically into larger units or terminal strips.

Extreme structural rigidity is provided to the socket by the specially designed supplementary buttress ribs which maintain the angle position of the socket to the printed circuit. Structurally, the ribs will withstand great pressure so that the socket cannot be bent out of position or torn from the circuit board.

The company designs, develops and manufactures printed circuits for customers' new or existing products.

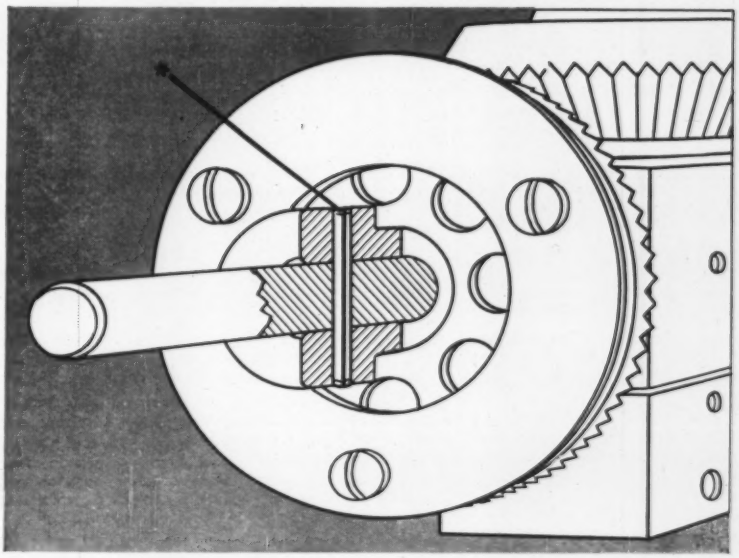
## Electronic Counter

A multipurpose electronic counter measuring frequency 10 cps to 1.1 MC, period 0.00001 cps to 10 KC, and time interval 3 microseconds to 27.8 hours has been announced by Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

The new counter, Model 523B, presents direct reading results in seconds, milliseconds, microseconds, or kilocycles. Accuracy of frequency measurement is ±1 count ± crystal stability of 2 parts per million per week. A special pulse output permits Z-axis modulation of an oscilloscope to visually observe time interval start and stop points on an input waveform, the company says.

The instrument includes a wide selection of gating and display times or may be controlled manually. An automatic illuminated decimal point is used to facilitate interpretation.


FASTENER PROBLEM



# Pinning costs for precision differentials reduced 25%

Using taper pins for assembly of these three precision differentials presented a cost-reduction problem to the PIC Design Corp. Tool cost, for example, was high because taper pins require fine, perishable and expensive taper pin reamers. Assembly costs, of course, were increased by the added reaming operation.

PIC replaced taper pins with Rollpin in all assemblies and cut fastening assembly time and costs substantially. The high cost of reaming has been eliminated entirely because Rollpin is a pressed-fit, slotted tubular steel pin which drives easily into holes drilled to normal production tolerances. Made slightly oversize, Rollpin compresses as driven. Its spring action locks it in place—withstanding impact loading, stress reversals, and severe vibration. And base price of stainless steel Rollpin is far lower than the equivalent taper pin.

If you use dowels, pins, rivets, or set screws and want to maintain high shear strength, consider the probability that Rollpin can cut your costs, too.

* 5 Stainless Steel Rollpins used on each PIC Precision differential.

ROLLPIN TRADEMARK

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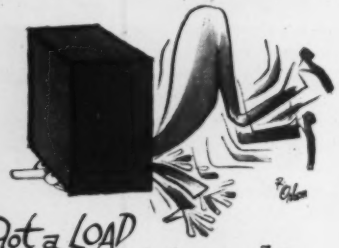

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## Cementable Tape

Garlock Packing Co., Palmyra, New York, announces the availability of cementable Teflon tape in thicknesses as low as .005 in. Heretofore cementable Teflon has been limited to thicknesses of $1/16$ in. and up, the firm says.

The thinner tape, lower in cost, will expand the use of Teflon as linings for conveyor guide rails, hoppers, baking pans, cookie flats and other work surfaces handling foodstuffs, corrosive materials, according to the company's announcement.

Nontoxic, noncontaminating, chemically-impervious Teflon tape is furnished with a slippery surface on one side and a specially prepared surface on the other side that can be bonded with commercial adhesives to wood, glass, metal, and other surfaces.

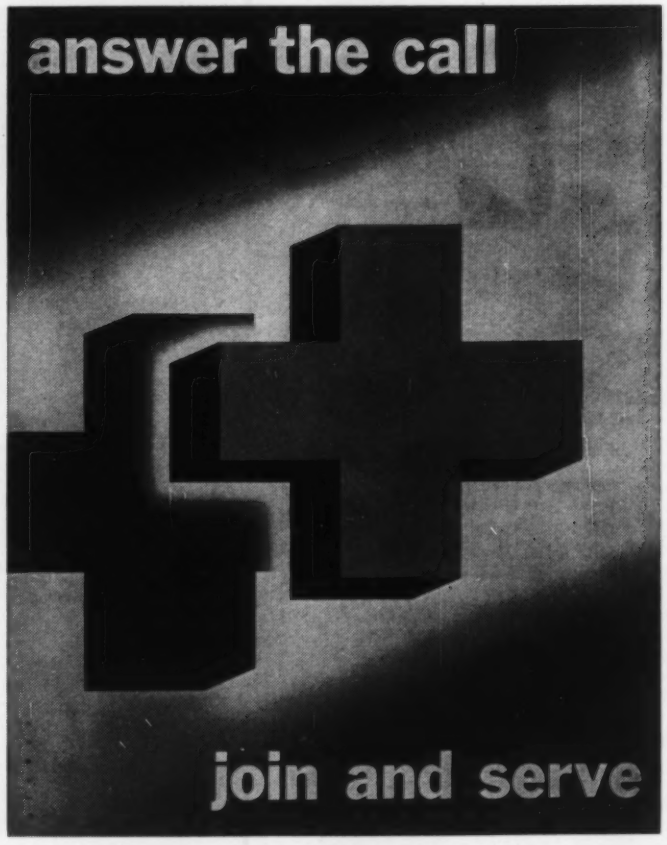
In addition to its anti-sticking surface characteristics, Teflon possesses excellent dielectric properties, and a broad service temperature range (−110 to 500 F), the company says. The new cementable tape is available in continuous rolls in thicknesses from .005 to .060 in. in width from $1/2$ to 12 in. Also available are cementable Teflon sheets (24 × 24 in. to 48 × 48 in.), in thicknesses from $1/32$ to 1 in.

## Combination Drive

A right-angle combination drive has been developed by U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif., for municipal water supply stations, sewage disposal plants, fire fighting stations and other installations where continuous or stand-by pumping service is essential.

Identified as the U. S. Holloshaft, Type GPC, sizes range from 30 to 150 hp and are available in a selection of gear ratios. In normal operation, an electric motor, mounted on the disengaged drive, powers the pump. In the event of a power failure or electric motor breakdown, the drive is then engaged to transmit power from a stand-by combustion engine with very little lost time under emergency conditions, the company explains.

A few of the features incorporated in the unit are heavy-duty motor stand and rust-proof aluminum cover to protect the external rotating parts from moisture and corrosion. A unique lower bearing retainer, which locks the hollow shaft against vertical movement, permits the drive to be engaged and operated up to a week's time without transferring the thrust load from the electric motor to the drive. All castings are normalized to remove internal stresses and prevent distortion.



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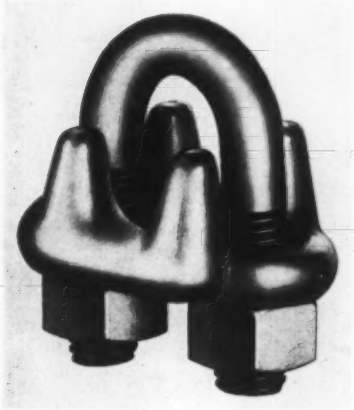

## Wire Rope Clips

Designated ACCO wire rope clips, these assemblies are drop-forged from high grade forging steel and are said to provide positive "grips of steel" for heavy-duty service. Introduced by the Wire Rope Div., American Chain & Cable Company, Inc., Wilkes-Barre, Pa., the clips are pre-packaged.

The base channel is shaped to hold the wire rope securely without damage to individual strands. They can be applied on the job and no vise or other special tools are required, the firm states.

The U-bolts, made of heavy steel, are protected against the formation of rust and corrosion by hot-dip galvanizing after threading. Threads are said to be exceptionally free running because no paint is used. Further protection is added by a green chromate coating which is applied after the galvanizing. The green chromate color also aids product identification. Bases of the assemblies are also hot galvanized as are the Standard American hex nuts.

The clips are manufactured to secure wire ropes of $\frac{1}{8}$ to $1\frac{1}{4}$ in. diameters. For the smaller assemblies—$\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, and $\frac{3}{8}$ in. sizes, they are packaged in lots of 100; for the $\frac{7}{16}$, $\frac{1}{2}$, $\frac{9}{16}$, and $\frac{5}{8}$ in. sizes, they are available in packages of 50; for the $\frac{3}{4}$, $\frac{7}{8}$ and 1 in. sizes, in lots of 25; and for the $1\frac{1}{8}$ and $1\frac{1}{4}$ in. sizes, in lots of 10 to a package. Weights range from 6 lb per package for the smallest size to 50 lb per package for the largest unit.

## Hydraulic Oil Coolers

A line of air type and water type oil coolers for industrial hydraulic systems is now available from Vickers Inc., Detroit 32, Mich. The coolers feature a high rate of heat transfer per unit of space occupied.

Designated Series OCW, water type oil coolers are available in single unit sizes for oil flows up to 100 gpm and for continuous power removals up to 37 hp (based on 85 F entering water temperature). The firm says greater requirements can be met with two smaller coolers of equal size used in parallel. Maxi-

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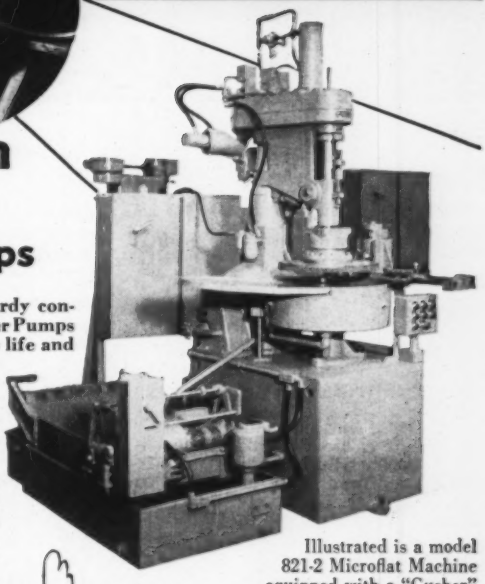
**Ruthman Gusher Coolant Pumps**



**The simple designs and sturdy construction of Ruthman Gusher Pumps assure you long trouble-free life and efficient operation. There are fewer parts to wear, pre-lubricated heavy-duty ball bearings require no further lubrication — electronically balanced rotating assembly cuts vibration to minimum. So be sure to specify the pumps that are designed to do a better job . . . "Gusher" Pumps.**

THE RUTHMAN MACHINERY CO.

Illustrated is a model 821-2 Microflat Machine equipped with a "Gusher" Coolant Pump—Photo courtesy of Micromatic Hone Corp.

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mum recommended working pressure is 75 psi for both the oil and the water sides.

Designated Series OCA, air type oil coolers are recommended by the company where cooling water is at a premium and/or waste heat can be used to warm space. Their exceptionally high heat transfer rate in relation to size results from a patented turbulator that breaks up the flow for maximum dispersion of oil against the walls of the heat transfer tubes.

The OCA coolers are available in single unit sizes for oil flows up to 70 gpm and for continuous power removals up to 13.2 hp (based on 100 F average ambient temperature). Greater requirements are met with units combined in parallel. Maximum recommended oil pressure is 150 psi.

### Spline Roller

Development of a new model Roto-Flo machine capable of performing one, two or three operations on a workpiece in a single pass is announced by Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich. The Model 1537 can roll a spline, or roll a spline plus an adjacent thread, oil groove, in a single pass of the forming racks, the firm states.

Under certain conditions, a third operation such as marking, can be added. Operations can be performed on same or different diameters but the forms to be rolled must be close together along the length of the shaft. The company says the unit's "chipless machining" which is up to 30 times faster than other methods, cuts manufacturing time still further by performing two operations in a single pass.

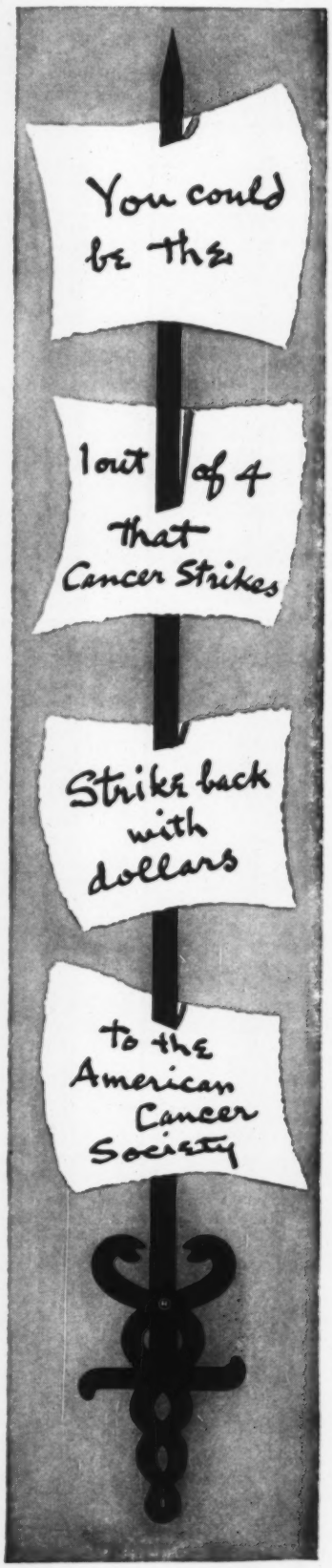
Basically, the Roto-Flo process is one in which the metal periphery of a part is displaced from its undisturbed condition by cold working until it assumes a desired shape such as spline, serration, etc. The entire process takes place in a matter of seconds as one continuous operation with the formed parts having excellent surface and tooth strength characteristics, the company says.

The machines are available with automation or as manually loaded models. If automated they can be operated throughout the complete forming cycle without any operator attention.

Parts with diameters ranging from ½ to 2 in. can be handled on the Model 1537. Rack lengths used are up to 36 in. with maximum stroke length being 42 in. Part lengths that can be accommodated by either standard or universal overarms available for spline rollers range from 6 to 36 in. The unit is 104 in. long, 74 in. in depth and 72 in. high. Power for the forming racks is provided by a 20 hp motor.


**For Consulting Engineers**
**Turn to Page 140**





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## Expansible Compounds

Two new thermosetting, self-curing poly-isocyanate foams for insulating and reinforcing voids between structural members are now available from Adhesives and Coatings Div., Minnesota Mining and Mfg. Co., 423 Piquette Ave., Detroit 2, Mich.

Designated as Scotchfoam expansible compound Type A and Type 1 the foams are said to be especially adapted to filling cavities where light weight, structural strength, stiffening, vibration dampening, and durability are desirable factors.

Both compounds are a two-part liquid formulation which, when mixed with a catalyst under proper conditions, can be foamed-in-place to produce a rigid cellular material that will not break loose, settle or sag. Application to desired areas may be made by pouring or spraying. Scotchfoam 1 has a volume expansion of approximately 20 to 1.

## Liquid Spring

Model 828 liquid spring for draw dies using liquid compressibility has been announced by Taylor Devices Inc., North Tonawanda, N. Y.

This new, compact, self-contained liquid spring doubles the stroke of equivalent coil springs while tripling the preload and end load with low spring rates and high spring force, according to the company. The construction permits the spring to be designed to approach a constant force. By the use of an exclusive internal hydraulic levering principle, the spring develops, with an identical or greater stroke, up to ten times the force of a standard heavy-duty coil spring of the same diameter and length, the firm says.

This liquid spring, 1 in. in diameter and $3^1/_2$ in. long plus mounting stud, has a $^5/_8$ in. stroke with a 480 lb preload and end force of 1000 lb.

The company says liquid springs reduce drawing operation costs by permitting simultaneous operations to be designed into compound dies thus reducing the number of single purpose dies. They also reduce the size and cost of dies by decreasing the number of required drilled and tapped holes. In addition, the reduction in downtime and damage from highly loaded broken die springs is an economical advantage, the firm states. The liquid springs with standard mounting threads are preloaded and completely self-contained eliminating stripper bolts and washers.

## Drum-Type Dryer

A new drum-type dryer, the Drumulator, for batch or continuous drying of feeds ranging from pasty or doughy mixes to distinctly granular material, is announced by Jeffrey Mfg. Co., Columbus, Ohio.

A stainless steel heated drum with flanged outer edges carries a continuous stainless steel belt. Material is dried in the space be-


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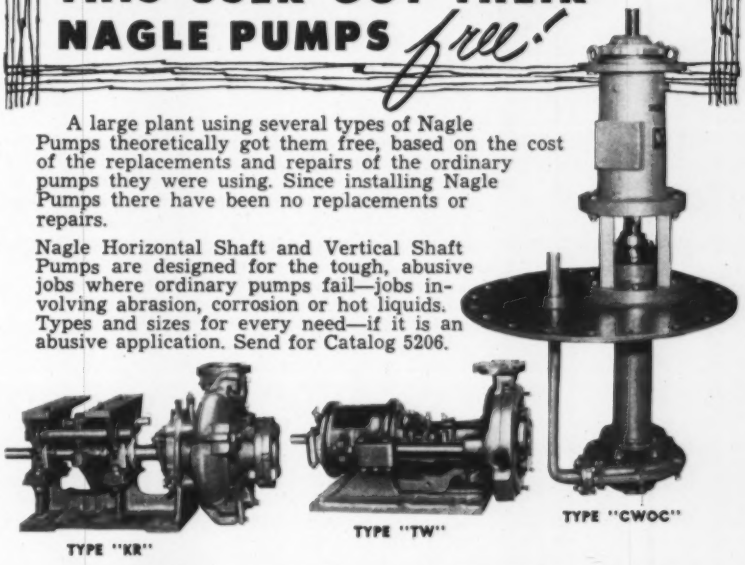


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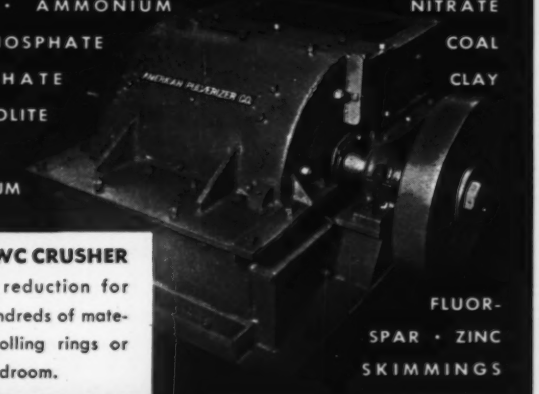

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Certainly, in competitive times such as these, it is necessary for any manufacturer to reduce costs wherever possible. But when cost-cutting affects product quality or efficiency, watch out. The saving in dollars and cents on a "cut-price" gear is usually pretty small, if there is a saving at all, over buying the gear that is assuredly "right" for the job. And if your specifications indicate possible use of a custom gear, talk to someone from Cincinnati Gear first and let him point out the advantages of custom gearing, and how good gears can be an economy in the long run. You'll find that putting the major emphasis on getting the *right* gear for the job will pay off handsomely.

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tween the heated surfaces of the drum and belt.

Material is forced across the drum face by continuous introduction of new feed material. It is in contact with the drum for two-thirds of a revolution—then plowed off and again fed to the drum.

The repeated plowing off and return of material agitates and mixes it, improving moisture release and presenting new material to the drum surface.

Material advances across the drum face a fraction of an inch with every revolution. Drying is complete when material has traversed the width of the drum and is plowed off into the discharge chute.

The steam heated drum is designed for maximum operating pressure of 150 psi. Gas, oil, hot air, or hot water can be used.

## BUSINESS NOTES

### To Build Chicago Plant

Charles Bruning Co., Inc., Chicago, manufacturer of Copyflex engineering reproduction machines and materials, has announced plans to build a new plant in Mount Prospect, Ill., a Chicago suburb.

The new plant will be one of the world's largest devoted to the manufacture of diazotype reproduction equipment and materials. It will more than double the size of the company's present two separate Chicago plants, which it will replace. The building will cover a 275,000 sq ft area on a 30-acre plot.

### Gets Injector Line

Sellers Injector Corp., announces the acquisition of the complete line of injectors formerly manufactured by the Ohio Injector Co. In addition to manufacturing rights, the transaction includes spare parts, servicing and reconditioning facilities, all of which are now available at the Sellers plant in Philadelphia.

### Pittsburgh Sales Office

Roots-Connersville Blower, Div. Dresser Industries, Inc., Connersville, Ind., is establishing a Pittsburgh sales office in the Grant Bldg., Rm. 2411, Pittsburgh 19, Pa.

### Expands Facilities

Bird-Archer Co., water treatment engineers, Philadelphia, Pa., has moved all facilities from New York to the company's headquarters in Philadelphia. A new laboratory, recently completed, doubles the firm's capacity to test water and conduct research. Addition of facilities and field personnel have resulted in a 100 per cent increase in speed on testing and engineering water treatment services, according to the company.


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## Opens Cleveland Branch

Lima Electric Motor Co., Lima, Ohio, announces the opening of a new branch office at 8905 Lake Avenue, Cleveland 2, to handle original equipment electric motor and gear-shift drive sales in the area.

## Opens Regional Office

The opening of a regional sales office in Kansas City to service an eight-state area has been announced by Corrulux Div. L-O-F Glass Fibers Co. The office will be located in the Merchandise Mart, 2001 Grand.

LATEST CATALOGS

## Centrifugal Fan Line

Trane Co., Lacrosse, Wis., has announced the revision of two fan bulletins to include new features and data on its line of Class I and Class II centrifugal fans.

Housings for the centrifugal fans are smaller, allowing for installation of the equipment in 3 to 5 per cent less space than previously possible. Also, in fan sizes 12 through 36-in., a new type of all-welded housing support is used. This support along with the lock-seam between the scroll and sides results in an extra sturdy housing.

The fans are manufactured in wheel diameter sizes 12 through 89 in., with either forward curved or backwardly inclined fan blade arrangements. Single and double width fans are available in all sizes. Class I fans have a maximum total pressure of $3^3/_4$ in., Class II, $6^3/_4$ in. Air volume capacities range up to 330,408 cfm.

## Steel Valve Designs

A 32-page marine catalog #256, which features the latest Rockwell-built Edward steel valves for marine applications, has been published by Edward Valves, Inc., East Chicago, Ind.

Valves listed conform to all requirements of US Coast Guard regulations and the various inspection, insurance and standards organizations. The new catalog also contains excerpts from the US Coast Guard marine engineering regulations.

## Weldrod Applications

Ampco Metal, Inc., 1745 S. 38 St., Milwaukee, Wis., recently printed the latest revision of its four-page Weldrod applications bulletin, W-25a.

The bulletin describes the characteristics, properties and sizes of the five grades of Ampco-Trode electrodes, both a-c and d-c; Phos-Trode; Ampco-Trode filler rod and coiled wire and Ampco-Braz Nos. 1 and 3. Typical applications are listed for each grade of electrode.

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## Lightweight Neoprene Belting

General Rubber Corp., Tenafly, N. J., has released a new four-page bulletin on lightweight Neoprene belting.

The belting is available in four styles: Custom, Sani-Flex, Multi-Duty and Rufftop, in widths, lengths, and thicknesses to meet any light duty horizontal or inclined conveying, elevating, and power transmission operations. All styles can be furnished vulcanized endless or with laps ready for vulcanizing.

## Valve Stem Packing

"Custom-Made Valve Stem Packings" is the title of a new bulletin just released by Packing Div., Raybestos-Manhattan, Inc., Passaic, N. J.

It describes the two general types in which they are available (braided of asbestos yarns, and plastic), the manner in which they are made and illustrates the shapes most commonly used, and lists size limitations. It also provides a recommendation chart for standard items when used against various fluids and gases.

According to the manufacturer, they can also supply valve stem packing rings, either die-cut or lathe-cut, from many types of rubber or synthetic rubber, with or without fabric reinforcement to meet individual requirements.

## Deaeration Bulletin

Cochrane Publication 4650 explains in capsule form the fundamentals of deaeration and why it is so necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed. Copies may be obtained from Cochrane Corp., 17th St. below Allegheny, Philadelphia 32, Pa.


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### Weldments Bulletin

Bulletin No. 7001, recently published by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., describes seven benefits to purchasers of weldments. Particular attention is given to the fabrication of large custom-designed weldments such as pressure vessels, bridge structures, vehicular tunnel linings.

### Designing Booklet

Prepared specifically for design engineers, "Designing With Kennametal" is a new booklet now being made available by Kennametal Inc., Latrobe, Pa.

The new 44-page booklet, B-222, provides mechanical information required by engineers who design parts that may call for the use of Kennametal or Kentanium, both products of Kennametal Inc.

### Plastic Laminates

Farley & Loetscher Mfg. Co., Dubuque, Iowa, has completed an eight-page brochure on its line of new industrial and decorative plastic laminates.

The catalog contains descriptions of the base materials, binders, sizes, tolerances, fabricating qualities, and types available of the products which are marketed under the name "Farlite."

### Physical Properties Card

A pocket-sized card listing physical properties of fasteners manufactured by the Cleveland Cap Screw Co., is now available.

Printed on vinyl plastic, the card gives such properties as steel analysis, head marking, tensile strength, Brinell and Rockwell hardness on screws up to $2\frac{1}{2}$ in. in diameter. Cards can be obtained from the company, Box 806, 2917 E. 79th St., Cleveland 4, Ohio.

### Speed Reducers

Increased overhung load capacity and longer life are said to be provided by standard double-enveloping worm gear speed reducers through the use of taper roller bearings on both worm and gear shafts. New specifications and horsepower ratings for models from 2 through 6-inch center distance are presented in Bulletin 600-C released by Cone-Drive Gears, Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

Cutaway photos, dimensional drawings and horsepower ratings at all speeds and ratios illustrate the bulletin. All of the standard reducers covered in the bulletin are available with worm over or under, or gear shaft vertical. Each standard model is also available with single or double extended shaft or shaft mounted, or either version as motorized models.


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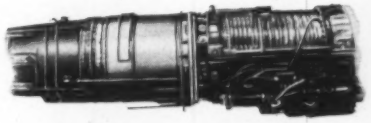

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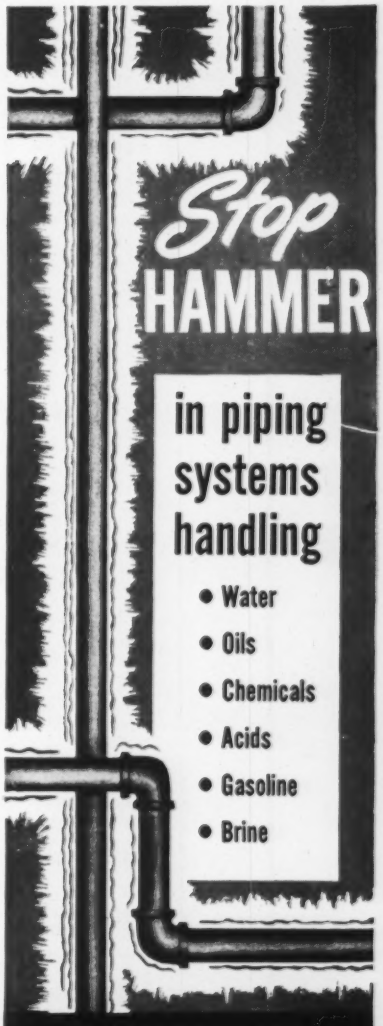


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## Quenching Oil

A new four-page bulletin on the filtration of quenching oils has just been released by Delpark Filters, Industrial Filtration Co., Dept. QO-200, Lebanon, Ind.

The brochure discusses the changes in quenching oils which occur when the oil is subjected to repeated quenching operations. These changes can affect the efficiency of the quenching oils and result in reduced operating efficiency and uneven quenches. The bulletin also tells how heat exchangers are kept free from sludge, the efficiency of the quenching oils retained and high quench quality of parts held constant through the use of the firm's filters.

## Remote Digital Weights

New developments that make possible the remote recording of weights in digital form are described in a brochure issued by Toledo Scale Co., Toledo 6, Ohio.

It is pointed out that weights are no longer limited to close proximity to the scale, or to any one type of recording. Weights now travel to almost any remote location and are fed directly into tabulators, tape punches, typewriters and other office machines. Weight graduations at the scale are scanned 120 times a minute to produce a direct digital signal that is electronically counted and transmitted to the office machines selected, or stored in punched tape form for later recording.

## Sewage Treatment

An architects' and engineers' reference manual dealing with pumping and sewage treatment equipment has been published and is available from Yeomans Bros. Co., Melrose Park, Ill.

The manual gives detailed information for determining capacities of, and selecting vertical wet pit pumps and pneumatic ejectors. Included in the section dealing with vertical wet pit pumps is a table for rating fixture units, a curve for estimating pump capacity and a table for determining friction of water in pipes. The section covering pneumatic ejectors discusses the various types available, how they operate, and how to select the correct pneumatic ejector for a given job.

## Bulletin on Filtration

Graver Water Conditioning Co., 216 W. 14th St., New York, N. Y., now has available copies of Bulletin WC-107A, Water Filters, Pressure Type.

The 12-page, illustrated bulletin describes the uses, design features and engineering details of pressure sand and gravel filters. Details of accessory equipment, the different types of controls available and a detailed table giving capacities, sizes and space requirements are included. Cutaway views of both horizontal and vertical filters are shown as well as details of strainers, distributor systems and piping arrangements.

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## Valve Catalog

"It's easier to open or close a Golden-Anderson valve than to drive a car with power steering" is the title of a new bulletin by Golden-Anderson Valve Specialty Co. In concise language and with the aid of simple drawings, the reasons for the claim made by the title are explaied. Additional features of Golden-Anderson cushioned automatic valves are also covered, plus a brief resume of 11 of the firm's complete line of specialty valves in sizes from 2 to 36 in.

Copies of Bulletin G-4 are available by writing to Golden-Anderson Valve Specialty Co., 1223 Ridge Ave., Pittsburgh 33, Pa.

## Steel Processing

An eight-page bulletin, "Chromallizing Improves Surface Properties of Steel," is available from Chromalloy Corp., 450 Tarrytown Rd., White Plains, N. Y. It describes the firm's process for increasing the heat, wear and corrosion resistance of steel by high temperature diffusion of chromium into the surface.

## Carbon Steel Tubing

Engineers and others involved in the design and operation of heat transfer equipment using tubing at elevated pressures will be interested in the data contained in a four-page technical folder released by the Tubular Products Div. of The Babcock & Wilcox Co. Known as TDC-142A, this bulletin furnishes condensed data on the mechanical and physical properties of seamless and welded carbon steel pressure tubing and supplies information on the various fabricating operations normally performed on such tubing. Copies of the folder can be obtained from the company, at Beaver Falls, Pa.

## Belt Idler Bulletin

A "Limberoller" belt idler booklet 2-80B, offered by Joy Manufacturing Co., 307 Oliver Bldg., Pittsburgh 22, Pa., contains design and application data for those who select, specify, purchase and use belt conveyors to handle bulk materials. Included are descriptions, dimensional drawings, specification tables and suggested applications for idlers and various troughing, impact, training and return brackets to use with belt widths of 18 through 72 in.

The "Limberoller" consists of resilient neoprene or rubber disks molded to a flexible wire rope, with a slip-fit, double-row, precision ball bearing on each swaged shank end. Bearings mount in slots at each side of a tubular upright bracket. The result is a single roll, freely suspended to form its own trough, and turning on its own axis.

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## Aluminized Wire

A 6-page color flyer, Bulletin DH-537, has been released by the Page Steel & Wire Rope Div., American Chain & Cable Co., Inc., Monessen, Pa. It describes ACCO aluminized products, wires that have the strength of steel and the corrosion resistance of aluminum.

Applications of this highly ductile wire, whose coatings withstand forming operations and the one-diameter wrapping test without fracture include: chain link fencing and barbed wire; ASCR core wire; strands for ground, guy and messenger wires; telephone wire; tie wire; and lashing wire. All are detailed. Physical characteristics and miscellaneous applications involving corrosion and corrosion coupled with high operating temperatures are also discussed.

## Gas Heating Equipment

A comprehensive catalog, GN-56, covering the firm's line of gas-fired commercial and industrial heating equipment has been published by the Reznor Mfg. Co., Mercer, Pa.

Equipment shown in the catalog includes suspended gas unit heaters, both fan and blower types in capacities from 25,000 to 250,000 Btu; a new deluxe suspended unit heater; the new Flexitemp floor model heater; two series of duct furnaces, with capacities from 50,000 to several million Btu; and the PAC, a horizontal furnace in sizes from 50,000 to 125,000 Btu.

## Rotating Limit Switch

Design features and engineering data about new rotating limit switch with heavy duty pilot ratings up to 480 volts are presented in Bulletin No. 5605, available from Furnas Electric Company, 1048 W. McKee Street, Batavia, Ill.

This four-page bulletin contains voltage rating charts, dimensional diagrams, wiring illustrations, application photos and list prices. Instructions for adjusting rotating limit switches are also furnished.

## Nickel Alloy Tubing

"Superior Tube Nickel and Nickel Alloy Tubing," a new 20-page catalog published by Superior Tube Co., 1715 Germantown Ave., Norristown, Pa., features handbook information on nickel and nickel alloys.

Although the catalog does not give complete technical data on nickel and nickel alloys, it points out that the firm's metallurgical engineers may be consulted at any time for advice on alloy selection, heat treatment and fabricating procedures for small diameter tubing. In addition to a general discussion of the properties of nickel and nickel alloys as a class, the catalog—designated as Catalog 12—tabulates for the specific mechanical properties and chemical compositions of 13 analyses of nickel and nickel alloy tubing drawn at the Superior mill.

## Heat Exchangers

Bulletin M-306 on standard heat exchangers for process industries has just issued by Lummus Co., Heat Exchanger Div., 385 Madison Ave., New York 17, N. Y.

The 18-page brochure includes a description of the design specifications and construction details of these standard units; tables of effective surface area available in the various units; tables of overall dimensions for these exchangers; and thermal design data, with tables of film co-efficients, pressure drops, fouling factors, and tube characteristics necessary to solve the basic heat transfer equations.

## Copper Casting Alloys

A 12-page catalog covering the range of beryllium copper casting alloys has been published by Beryllium Corp., Reading, Pa.

The catalog is divided into five sections covering available alloys, properties, advantages, casting and processing techniques. Basic descriptions of four available casting alloys and their properties are given in text together with a series of reference charts and tables. Casting techniques are covered with particular emphasis on sand casting. Information covers molding, melting, and pouring techniques as well as safety precautions.

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NEW EQUIPMENT
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## Metal Marking Catalog

The Noble & Westbrook Mfg. Co., producers of metal marking machines and tools has just released a new 50th Anniversary catalog containing the complete Noblewest line with illustrations of marking applications. Printed in three colors the catalog includes basic technical information on metal marking, rapid production marking machines, the Noblewest Series 50 general purpose marking machines, precision graduating equipment, mechanical and pneumatic marking presses, bench marking machines, automatic numbering heads, precision marking dies and hand marking tools. Also included are new marking machines capable of production speeds up to 15,000 pieces per hour with full automation, and the new Noblewest cyclomatic control for cycling and sequencing marking machine operations.

Copies of the catalog may be obtained by writing to Richard H. Gunther, Noble & Westbrook Mfg. Co., Westbrook St., East Hartford 8, Conn.

## Vulcanized Fibre

"Vulcanized Fibre—The Laminated Plastic With A Million Uses" is the title of an eight-page reprint currently being offered by National Vulcanized Fibre Co., 1056 Beech St., Wilmington 99, Del.

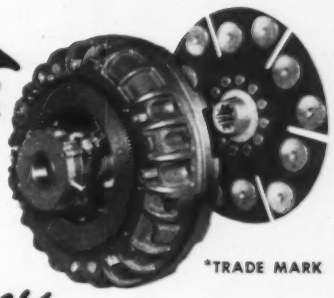
The article tells how, for more than 80 years, manufacturers in all industries have found new and important cost-saving uses for this versatile cellulose plastic material. It covers the physical and chemical properties of the many grades (including commercial fibre, bone fibre, electrical insulation and trunk fibre) as well as fabrication methods such as drilling, blanking, forming, piercing, and lathe turning. Also contained in the reprint are 10 illustrated case histories showing how vulcanized fibre solved design and manufacturing problems for companies in various industries.

## Carbide Dies

A 48-page booklet on carbide dies published by Oberg Mfg. Co., Inc., Tarentum, Pa., illustrates and explains how the firm's carbide-die experience and craftsmanship can help solve tooling-up problems when high production, critical tolerances and part quality are at stake.

The booklet discusses the company's "Package Program" which consists of a study of the production problem, design and building of the die, construction of precision-engineered auxiliary tooling, and production proving of the complete tooling in Oberg's own presses before shipment. Separate sections provide detailed information on dies designed to solve specific problems; special features for best performance of carbide dies; calculations to determine blanking and stripping pressures; sharpening-wheel selection; lubrication of dies and material; general care of carbide dies; and carbide characteristics.


ROCKFORD



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CLUTCHES


## Rotary Transfer Machines

Ferguson Machine & Tool Co., PO Box 5841, St. Louis 21, Mo., has issued a 24-page Catalog 301 giving load ratings and dimensions of more than 150 standard high speed "Intermittor" index tables with many in stock for immediate delivery.

The line, including dial sizes ranging from 12 to 120 in. with from 4 to 36 stations, features extreme precision without auxiliary locking methods, production speeds up to 30,000 pieces an hour and at least 8000 hr operation without maintenance. The company says standard power assemblies, stands and control panels may also be ordered from stock to form a complete rotary transfer machine for automatic assembly.

## Control Valve Bulletin

Three- and four-way directional control valves built by The Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis., for fluid power systems up to 3000 psi, are described in this new 16-page Bulletin 80300.

Included are details of the valve body construction and the functions of standard and special plungers. A wide choice of plungers and flanges is offered in the four styles of operators, mechanical, manual, hydraulic and solenoid pilot. Each style is described and the type designation, dimensions and J. I. C. symbols are included. A page on custom-built valves illustrates special direction control problems.

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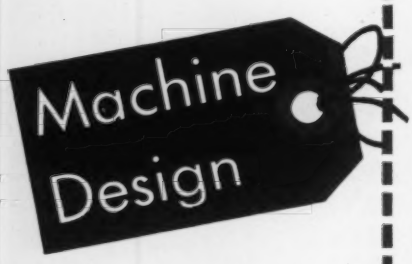


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## Toolholders, Carbide Inserts

Vascoloy-Ramet Corp., Waukegan, Ill., has issued a 24-page catalog No. VR-437 describing its line of toolholders and carbide inserts.

The catalog covers positive and negative rake toolholders utilizing throw-away inserts and negative rake toolholders using standard inserts up to $1^1/_2$ in. long. The firm says these toolholders handle an estimated 90 per cent of all machining operations. Both carbide and ceramic inserts can be used. Illustrations of various styles of toolholders to replace standard brazed carbide tools plus physical dimensions, prices and ordering information for toolholders and square, triangular and round carbide inserts are included.

## Bulk Conveyor

A 12-page folder on the design and use of conveyors for handling bulk materials and containing engineering data and actual in-use installation information on several types of bulk handling conveyor systems can be obtained from Jervis B. Webb Co., Dept. NLP, 8951 Alpine Ave., Detroit 4, Mich. Ask for Bulletin 455.

## Limit Switches

Bulletin 356 on machine tool limit switches describing 19 contact arrangements available with seven Loxswitch models, is to be had from R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W., Cleveland 13, Ohio.

The direction of lever movement, direction of spring return, and normal and operated circuits for each position is given in table form. The brochure shows a cutaway drawing of the new Loxswitch heavy duty oil and water tight models which meet the new NEMA 12 specification. Comparative statistics are also given of the three leading machine tool limit switches based on independent laboratory tests, together with a report on a test conducted on the same makes of switches.

## Lubrication Systems

An illustrated bulletin, No. 1450, describing Dravo-DeLaval lubrication and coolant systems has been prepared by Dravo Corp., Fifth and Liberty Ave., Pittsburgh 22, Pa.

The four-page bulletin contains several pictures of typical installations and a diagram of a mill lubrication system. The systems are custom designed to supply the correct amount of lubricant to the right place at the proper temperature and pressure to meet specific requirements of lubrication and cooling. The firm states that the systems provide maximum protection at vital gear meshing points and bearing surfaces. The bulletin also describes the company's Unilube Units, which are compact, packaged lubrication systems designed to meet the need for an economical full pressure feed lubrication system in capacities up to 50 gpm.

The bulletin, No. 1450, may be obtained from Dravo Corporation.

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

## Slide Valve

Data Sheet Ub, from Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa., describes the company's line of universal slide valves, designed especially for use in pipeline transporting solid materials in liquids.

The four-page sheet describes a design of slide valve which provides straight through flow in the open position with full pipe diameter. Details of construction are covered in text and illustrated, together with operating mechanisms for manual or power operation. Line diagrams with dimension tables give pertinent size data for various models.

## Plastic Piping

A 12-page catalog, illustrating and describing its line of corrosion-resistant polyethylene and polyvinyl chloride pipe, tubing, ducting, valves and fittings for industrial applications has been released by the American Agile Corp., Box 168, Bedford, Ohio.

Information includes a summary of pipe materials in comprehensive form; an explanation of fabricated pipe fittings; details on larger dimensions of cast pipe; properties of pipe materials; and a listing of available literature offered by the company.

## Vibration Control

A new bulletin issued by T. R. Finn & Co., Inc., describes the basic theory of vibration isolation and shock absorption. It describes various types of machinery vibration, gives basic data, formulas and graphs that enable the reader to recognize his own problem, and reviews practical methods of shock vibration and control. Copies of the bulletin, SVC-55, may be had by writing to T. R. Finn & Co., Inc., Industrial Div., 200 Central Ave., Hawthorne, N. J.

## Stainless Steel Castings

A designation chart, Bulletin 156-H, for heat resistant stainless steel castings has been prepared by Empire Steel Castings, Inc., Reading, Pa., to correlate the ACI designations with corresponding AISI type numbers and ASTM designations.

The chart also gives the percentage of principal alloying elements in the seven heat resistant stainless types which it covers. Additional information includes typical mechanical properties of these types, notes on their application, and a chart of some typical high-temperature properties of several heat resistant alloys. Creep stress data are included.

## Unit Heater Bulletin

Latest improvements, specifications, and complete performance data for Herman Nelson horizontal and vertical unit heaters have been written into a new 36-page product bulletin by American Air Filter Co., Inc.

Bulletin No. 700A includes hot water and steam performance tables, dimensions, selections, applications, descriptions of cabinets, elements, motor mountings, fans and accessories, controls, suggested layouts, piping diagrams, and other technical data. It is available from American Air Filter Co., Inc., 215 Central Ave., Louisville, Ky.

## Wire Rope Manual

A revised edition of Jones & Laughlin Steel Corporation's manual on wire rope has been completed and is now available. This 96-page manual entitled "Wire Rope is a Machine" contains extensive information on the selection, installation, and best operating practices for wire rope.

Included in this revised edition is new material on the applications of JalKlamps and JalFlex slings. Copies of this manual can be secured by writing Wire Rope Div., Jones & Laughlin Steel Corp., Muncy, Pa.


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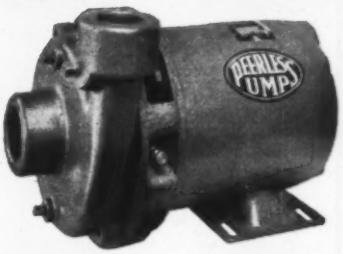


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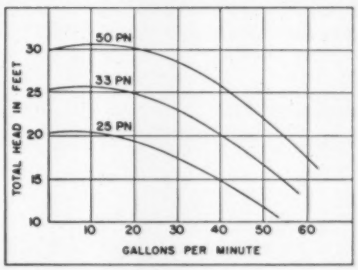


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### Lubrication Guide

A 20-page, lubrication guide offered by Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., covers lubrication systems and requirements of all machinery built by the firm's four divisions Equipment covered includes bolt, nut, screw and rivet machinery; power presses; wire, rod and tube machinery and rolling mill machinery.

The guide, extensively illustrated, explains in detail the following systems used singly or in combination: circulation oiling, centralized pressure lubrication, bath-splash oiling, centralized gravity feed and hydraulic systems. Text describing each system is accompanied by photos of typical machines employing the particular system.

### Plastic Products Brochure

A new brochure covering R/M plastic products made of "Teflon" and "Raylon" has just been released by Plastic Products Div., Raybestos-Manhattan, Inc., Manheim, Pa.

In addition to furnishing complete information on the chemical, electrical and mechanical properties of "Teflon" and "Raylon," it also provides complete specifications on the various sizes in which sheets, tape, molded and extruded rods and tubes of "Teflon" and "Raylon" are available. It suggests, too, typical applications where these products will provide excellent service to the user.

### Pre-Cast Insulated Stack

A comprehensive 80-page literature file on pre-cast insulated stack is now available to architects and engineers on request from Van-Packer Corp., Bettendorf, Iowa.

This bound file is indexed into 4 categories: general information; specifications and ordering data; installation instructions, including buying methods; and performance and physical characteristics. The first category includes detailed description, advantages and photos of the stack. Thirty-two pages of test data are included in the fourth category.

### Self-Operating Regulator

A new bulletin on the Cash Standard Stacon series V self-operating temperature regulator is now available from A. W. Cash Co., PO Box 551, Decatur, Ill. The regulator is recommended by the company for steam, water, gases and all fluids not corrosive to brass.

It operates on a liquid filled thermostatic system, either direct or reverse acting. The direct acting model is designed for applications on hot water heaters, tanks, kettles, plating tanks, bottle and can washers, dryers, metal parts washers, degreasers, ovens and fuel oil heaters. The reverse acting model serves such operations as jacket cooling (for compressors, diesel and gas engines) brine circulating and process cooling. A new bulletin contains such data as weights and dimensions, pressure and temperature ratings accessories, construction and performance characteristics.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

## Hydromatic Valve

Cochrane Corp., 17th St., Philadelphia 32, Pa., announces Publication 5813, describing hydromatic valve used in the control of demineralizers, Zeolite softeners, dealkalizers and pressure filters.

The valve was developed to eliminate the complicated nest of individual valves required for the control of the various stages of service, backwash, regeneration, rinse and return to service. The valve can be operated either automatically or manually. The publication describes the design features, operation and advantages the hydromatic valve offers operators of ion exhcange equipment.

## Power Transmission Equipment

A line of power transmission equipment, including flexible couplings, variable speed pulleys and transmissions, universal joints and motor bases, is described in a 12-page illustrated technical brochure issued by Lovejoy Flexible Coupling Co., Dept. MXN, 4800 W. Lake St., Chicago 44, Ill.

Information includes operating data, horsepower ratings, sizes and types for varying working conditions. Flexible couplings are of the non-lubricated type. Light-duty types use spider-type cushions, while those in the medium and heavy duty range utilize individual load cushions. Special types feature radial removability, direct connection to engine flywheel, brake drum flange and units bored for taper lock bushings. Hp ratings are from fractional to 3,000. Torque (static) ranges from $1^1/_2$ to 5,100 ft-lb.

## Aircraft Accessory Systems

Stratos Div. of Fairchild Engine and Airplane Corp., Bay Shore, Long Island, N. Y., has issued an illustrated, four-page booklet on its accessory systems for basic aircraft services.

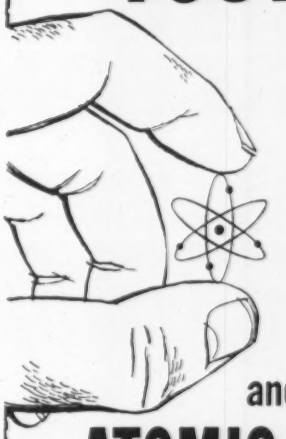
The booklet describes, with model numbers and pictures, pressurization and air conditioning systems, high and low pressure compressors, valves and controls and a complete group of pneumatic accessories.

## Floor Armors

A 12-page specification and installation manual illustrating the latest methods for prolonging the life of industrial floors with Hexteel and Floorsteel has been published by the Klemp Metal Grating Corp., 6615 South Melvina Ave., Chicago 38, Ill. Hexteel and Floorsteel are the firm's heavy duty steel floors armors. Hexteel is a rigid surface armor; Floorsteel is a flexible steel armored mesh.

The new manual is a specialized report containing several pages of data tables, filler weights, specifications; illustrated installation procedures and various specialized uses of the armors in such industries as the oil, chemical and railroads.

**YOU..**



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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

## Bridge Instruments

A bulletin covering the company's Dynamaster electronic potentiometer and bridge instruments for recording and controlling, has been published by Bristol Co., Waterbury 20, Conn.

The two-color bulletin gives details of the instrument and its components and the principles of operation. Full specifications are listed for the various models of recorders, and automatic controllers available. These include 3 and 12-in. strip-chart and 12-in. round-chart recorders, and both air and electric control models. Single and multiple variable recorders are listed, as well as a new high-speed recorder.

## Welding Directory

Lincoln Electric Co., Cleveland 17, Ohio, has revised its "Weldirectory for Mild Steel and Low-Alloy High-Tensile Steels" (SB-1351) to include newest iron powder and other electrodes. This bulletin provides a description of each electrode, its physical properties and chemical composition, recommended welding procedures, an operator's reference table, and a list of typical applications for each electrode.

## Electric Brakes, Clutches

Warner Electric Brake & Clutch Co., Beloit, Wisconsin has announced the availability of an eight-page bulletin Form WEB-6212, which describes the firm's line of electric brakes and clutches.

Included in the bulletin are specifications for primary electric brakes, clutches, and clutch-brakes; fractional horsepower RF electric brakes, SF electric clutches and clutch-couplings; and integral horsepower electric brakes and clutches. Also included is information on controls and packaged electric motor brakes.

## Power Transmission

A new engineering catalog covering the firm's line of mechanical power transmission products is announced by Dodge Mfg. Corp., Mishawaka, Ind. Imprinted copies for key personnel are being furnished to industries by authorized distributors of the firm.

The catalog contains 328 pages of information on products, including sectional drawings, dimensions, weights, prices, application details and engineering tables. Eight pages are devoted to a detailed index of all material in the catalog.

## Vibratory Equipment

Eriez Manufacturing Co., Erie Pa., is offering a six-page, two-color folder describing its recently announced new type of electro-permanent magnetic vibratory equipment.

Called Hi-Vi, the new line of equipment consists of vibratory feeders to feed bulk materials at carefully controlled rates of speed and unit vibrators to speed and assure the flow of materials from bins and hoppers. The brochure describes the new design which incorporates a lifetime permanent Alnico magnet and an a-c electromagnet. No separate rectifier is needed.

## Filter Bulletin

Filters for raw water, light process liquids, and centralized coolant systems are described in the revised bulletin No. 052 on Flo-Klean filters, available from Cuno Engineering Corp., Meriden, Conn.

These filters can handle up to 15,000 gpm in a single unit and can filter down to .0025 in. They are continuously and automatically self cleaning, require minimum maintenance and occupy small floor area.


THE SHAPE OF THINGS IN MOLDED SILICONE

SILI-CONE PROVES REAL COOL
...FOR JET AIRCRAFT EQUIPMENT

This Dow-Corning 301 thermal barrier for jet aircraft accessories was developed by Acushnet for a well-known aircraft accessories manufacturer. The idea was to attain a part that would provide maximum physical properties at temperatures over 800°F.

Designing and constructing a preform overcame the high bulk factor of the compound. Thorough testing of the original mold under various temperatures and pressures provided necessary information in curing Dow-Corning 301 compound. Test results enabled Acushnet engineers to design and construct a compression mold of hardened steel that made this part possible.

Pioneers in the advanced mold techniques and custom compounding of silicones, Acushnet now offers you immediate technical assistance in the molding and finishing of silicone resins.

What's Your Shape?

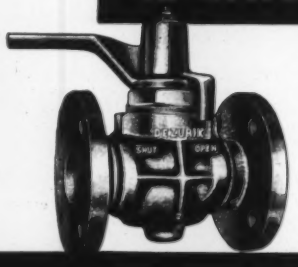
*Send for Acushnet "Silicone Rubber Brochure."*

Acushnet ACUSHNET PROCESS COMPANY
NEW BEDFORD, MASSACHUSETTS

... *Precision Molded* RUBBER, SILICONES - "APCOTITE" BONDING

Address all communications to 752A Belleville Ave., New Bedford, Mass.

IN SPITE OF GRIT



OR OTHER SOLIDS IN THE FLOW . .

DeZURIK VALVES

DON'T LEAK!

EXCLUSIVE ECCENTRIC ACTION

squeezes the resilient plug-face against the seat—sealing shut *around* particles in the flow that cause leaking in ordinary valves. In opening the valve, the first fractional movement of the lever lifts the plug free from the seat and the plug swings out of the way smoothly, easily, with only a quarter-turn of the lever. There's no binding! No friction! No lubrication! *Write for details. Representatives in all principal cities.*

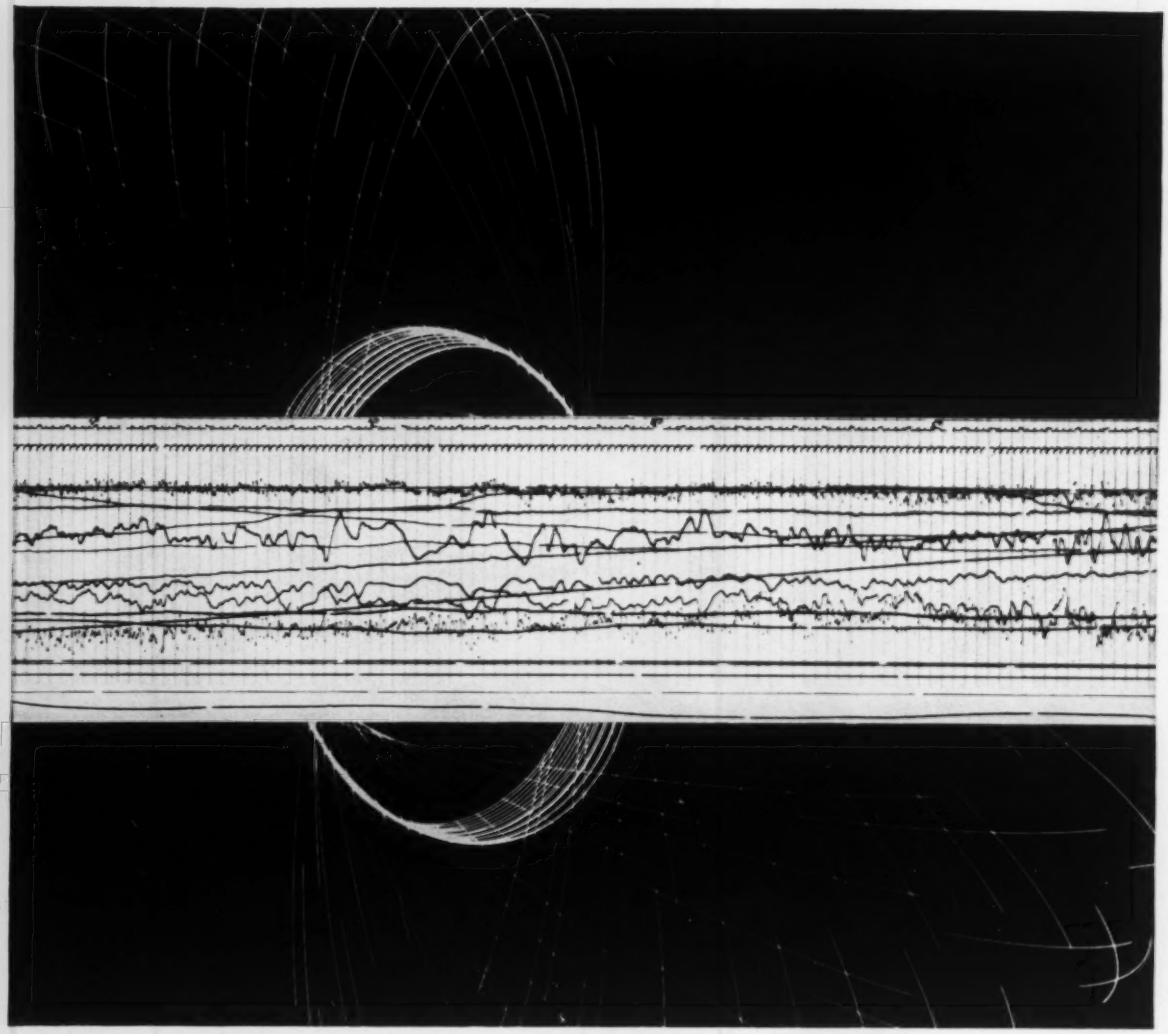
DeZURIK SHOWER CO.
Sartell, Minn.

the **real** engineering opportunities

are in DENVER, Colorado with the Martin Company . . .

where the creative challenge of exploring the problems of space is blended with the advantages of living in the heart of one of America's most popular vacation lands. Martin invites Aeronautical, Mechanical, Electrical and Structural Engineers and Technicians as well as Mathematicians and Physicists to accept this challenge and *write to Emmett E. Hearn, Dept. C-5, P. O. Box 179, Denver 1, Colorado.*

**MARTIN**
DENVER DIVISION



$$\delta = \sum_{i=0}^{1} f_i\,(M,\ P)\ \frac{d^i\theta}{dt^i} + \int_0^t \left\{ K_1\,(M,\ P)\ \theta + [K_2\,(M,\ P) + t - \tau] \sum_{j=0}^{2} f_j\,(M,\ P)\ \frac{d^j h}{d\tau^j} \right\} d\tau$$

This equation is one of the many in daily use by engineers at AUTONETICS—pioneers in the important business of electro-mechanics. They employ it as a step in the design of automatic flight control equipment for supersonic aircraft. New light is shed on the meaning of equations such as this in the AUTONETICS Flight Control simulation laboratory—one of the best equipped in the country.

Furthermore, AUTONETICS engineers check their findings under actual operating conditions. They completely proof test and make final systems analysis with airplanes that are in readiness for every phase of actual flight test.

AUTONETICS' 2500 man engineering department—organized 10 years ago—has full capability in research, development, design, manufacture and test of complete systems in data processing, inertial guidance, autopilots, armament controls, computers (analog and digital) and other special products.

For more detailed information, or for employment in any one of these fields, please write: AUTONETICS, Dept. ME - N3, 12214 Lakewood Blvd., Downey, California.

**Autonetics**

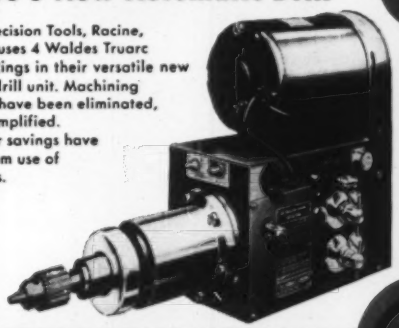
A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

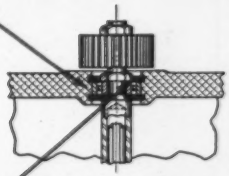
# 4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

## Dumore's New Automatic Drill

Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

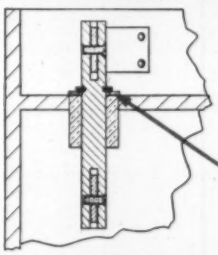


## Drive Spindle Assembly



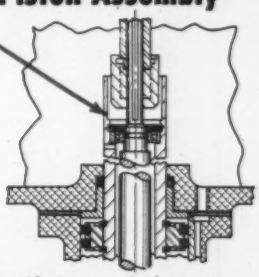
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

## Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

## Piston Assembly



Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

**Whatever you make,** there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

**36 functionally different types**...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

**More than 30** engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

**For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!**

Send for new catalog supplement

**WALDES TRUARC® RETAINING RINGS**

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
*(Please print)*

Name_____
Title_____
Company_____
Business Address_____
City_____ Zone____ State_____
Mc 7/8

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

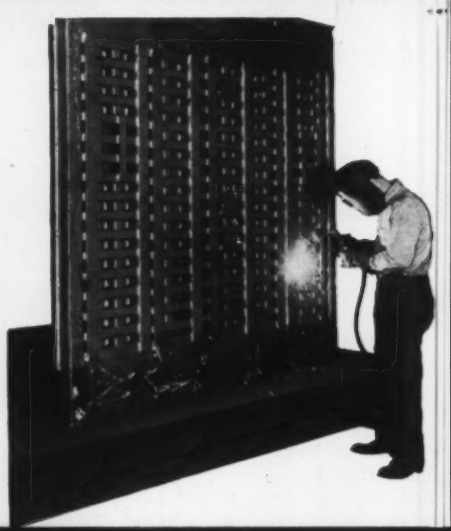
# HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS...

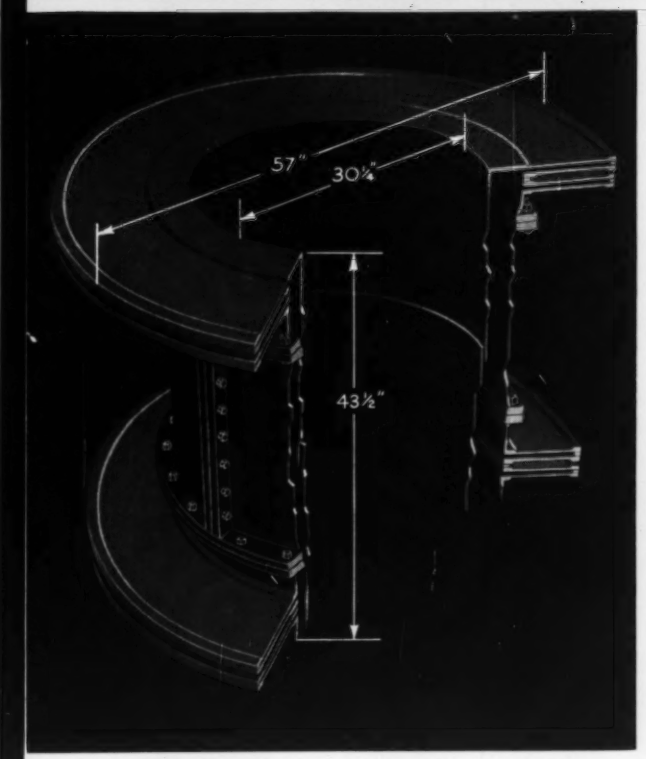
## . . . Lops off 1,047 Pounds

Trays for ore clean-up buckets need tremendous resistance to impact, abuse and abrasion. Blaw-Knox Company, Pittsburgh, Pa., found that they weigh half a ton less, and cost less to fabricate when made from USS "T-1" Steel plate instead of heavy steel castings.

## . . . 534 Easier Welds

This printing press bedplate, manufactured by Graver Tank & Manufacturing Co., Inc., must be welded in 534 places. High alloy steel with the needed strength was very difficult to weld. But USS "T-1" Steel is easy to weld . . . and has the needed strength to keep these bedplates, used on high-speed printing presses, as lightweight as possible.






## . . . Saves $18,043

In structures like this, which are steel bellows that flex up-and-down and sideways, large thermal expansions can be accommodated. These expansion bellows surround struts which support a large axial flow compressor rotor. The bellows are connected from the compressor stator to the foundation. Westinghouse Electric Corporation switched to USS "T-1" Steel . . . promptly cut not only the cost of machining and welding, but also cost of the steel itself—saved $18,043.

## . . . Three Ways Better

International Nickel Company of Canada expects USS "T-1" Steel to increase the service life, to reduce the maintenance, and lower the long-term cost of ore cars like this one; because "T-1" Steel has far greater strength, toughness, and resistance to abrasion than steel used previously. The car builder, Canadian Car and Foundry Co., Ltd., has had no difficulty fabricating this very strong alloy steel.

# HOW USS "T-1" STEEL CAN HELP YOU

The great strength and toughness of USS "T-1" Steel (90,000 psi. minimum yield strength) helps you to increase the capacity and durability of power shovel buckets and storage tanks without increasing weight.

Its excellent weldability enables you to fabricate large equipment out in the field without heat treatment . . . thus, reduces fabricating and shipping costs and speeds up construction.

Its unusual toughness at sub-zero temperatures helps you to lengthen service life of equipment that must take impact, abrasion, and abuse in all weather.

USS "T-1" Steel also gives you good creep rupture strength to 900° F. It often can be substituted for more expensive steels that are more difficult to fabricate. There is a place for "T-1" Steel somewhere in your designs. Write, wire, or phone for more information. United States Steel, Room 5386, Pittsburgh 30, Pa.

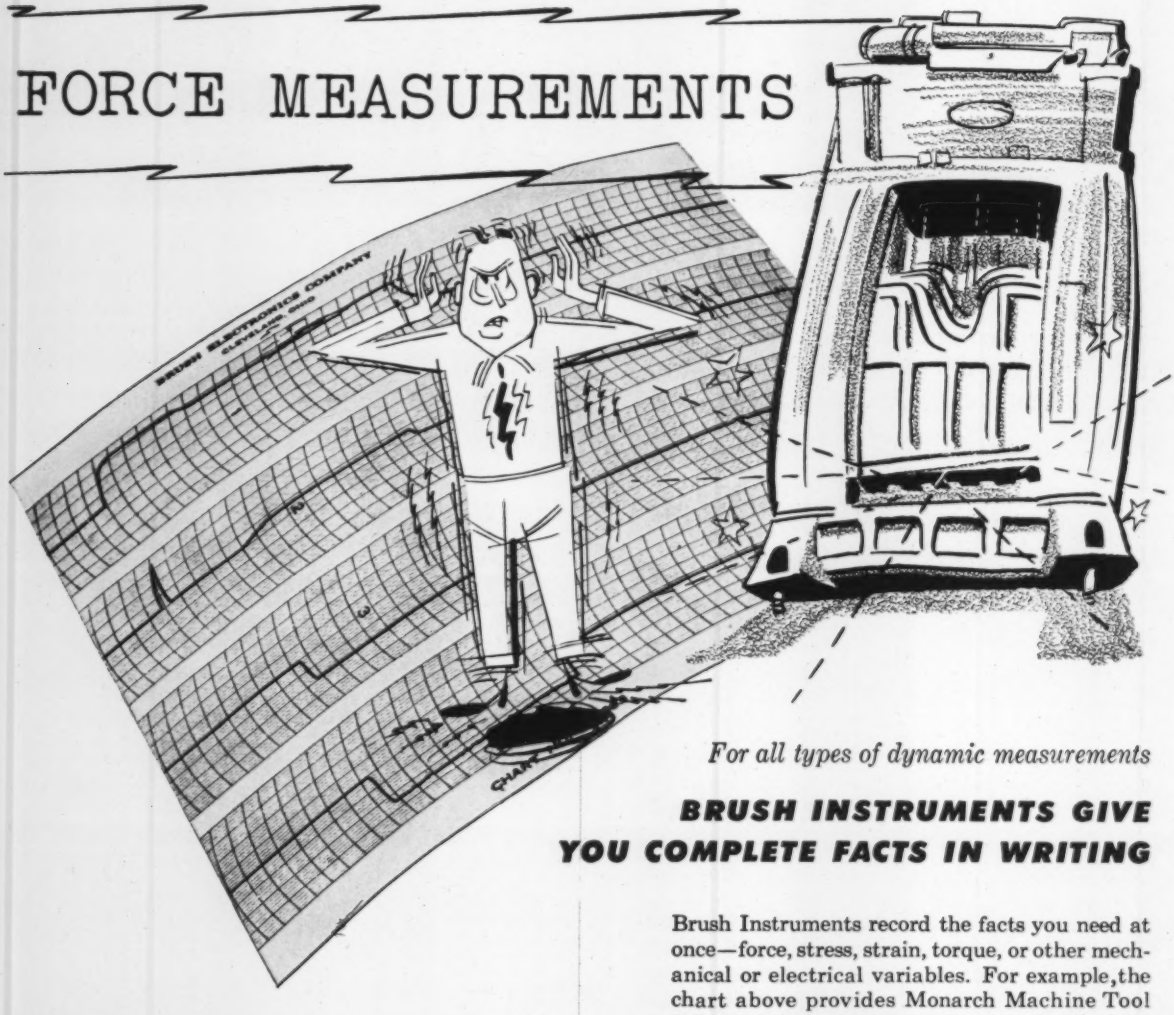
UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

**USS "T-1" CONSTRUCTIONAL ALLOY STEEL**

USS

UNITED STATES STEEL

# FORCE MEASUREMENTS



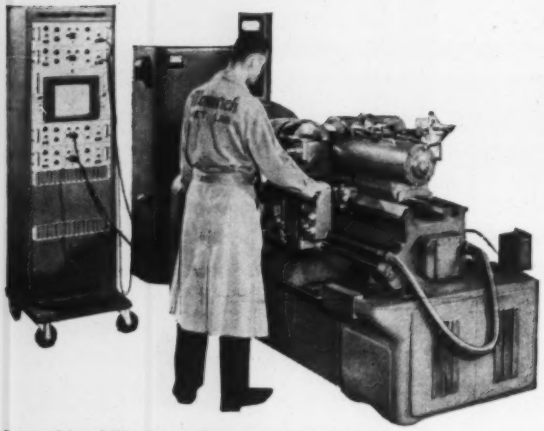

*For all types of dynamic measurements*

## BRUSH INSTRUMENTS GIVE YOU COMPLETE FACTS IN WRITING

Brush Instruments record the facts you need at once—force, stress, strain, torque, or other mechanical or electrical variables. For example, the chart above provides Monarch Machine Tool Company with important answers on the metal cutting process . . . answers obtained quickly and accurately with a minimum of engineering time.

Monarch has set up a Machineability Test Lathe equipped with dynamometers to measure cutting or vertical force and feed force. These values, as well as spindle speed and driving power, are immediately recorded by Brush Instruments as tests are going on. Thus cutting recommendations can be provided quickly for different requirements.

Brush offers a complete line of electrically controlled direct-writing recording systems for test laboratory or portable field use that can help you in virtually any measurement problem. Get the facts from your Brush representative. Or write for booklet to Brush Electronics Company, Dept. P-7, 3405 Perkins Avenue, Cleveland 14, Ohio.



In machineability test at Monarch Machine Tool Company, a complete written answer to the test problem is available before the spindle comes to rest.

**BRUSH ELECTRONICS**
3405 Perkins Avenue, Cleveland 14, Ohio

BRUSH ELECTRONICS

**COMPANY**
DIVISION OF
CLEVITE CORPORATION

These are Zallea Pressure-Balanced Expansion Joints. They provide a sound engineering solution to the problem of absorbing pressure thrust where a change in direction occurs, and it is not possible to anchor the elbow.

Their operation is simple. Both expansion joints shown are designed to absorb axial and lateral movement in the inboard bellows. By means of tie rod action, the pressure thrust of the inboard bellows is balanced by the countermovement of the outboard bellows. This design is frequently used in piping connections to a turbine to eliminate the pressure thrust against the turbine casing. Many other applications may occur to the design engineer.

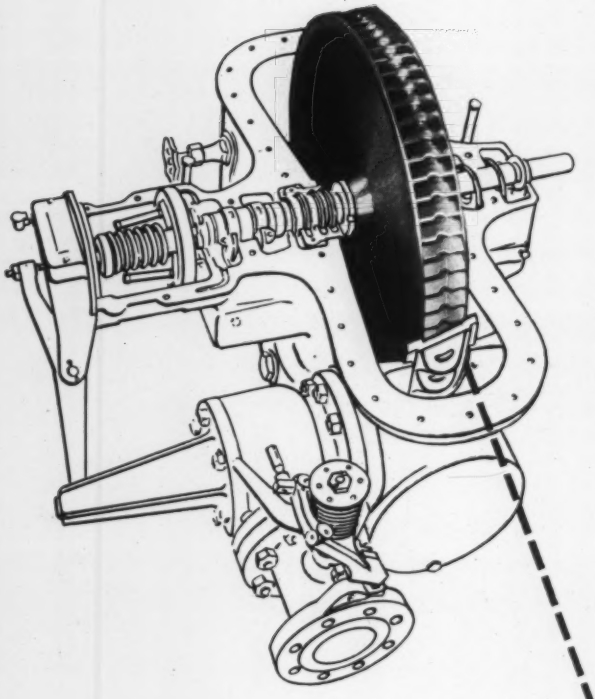
An original Zallea design, these specialized joints are another example of our ability to develop, engineer and manufacture expansion joints to meet your specific needs. For information on standard types, or help with special expansion or piping problems, call in a Zallea representative.

*Zallea* *expansion joints*

ZALLEA BROTHERS, 820 LOCUST STREET, WILMINGTON 99, DELAWARE

*World's Largest Manufacturers of Expansion Joints*

# Work Horse of Industry..since 1906



The Terry Steam Turbine Company was incorporated in 1906 to manufacture *a workable and efficient prime mover that would operate with minimum maintenance.* This prime mover was the solid-wheel turbine, which had been invented by Edward Clinton Terry a few years before.

Although maintenance practice has improved vastly since then, the demand for the turbine has multiplied many times. *Rising maintenance costs have actually increased the need for trouble-free operation.*

Today, there are more Terry solid-wheel turbines in operation, and there are more built each year, than ever before. The explanation is simple.

Here is a turbine with a virtually indestructible wheel. Made of a single forging of special composition steel, there are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which may occur does not materially affect horsepower or efficiency.

Blades will not foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

These are a few of the reasons why the Terry solid wheel turbine has been the *work horse of industry — since 1906.* For the full story, send for a copy of Bulletin S-116.

**THE TERRY STEAM TURBINE COMPANY**
**TERRY SQUARE, HARTFORD 1, CONN.**

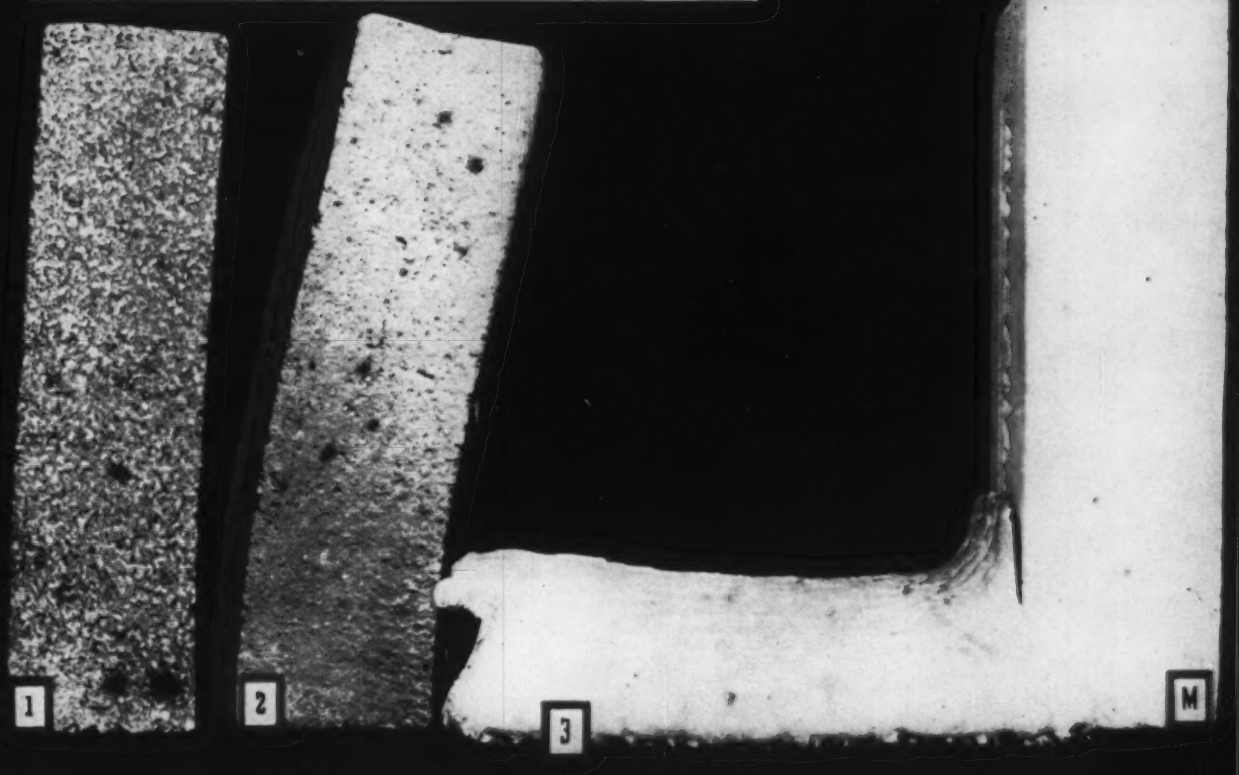
TERRY

**1906** was the year this turbine was built in Terry's plant. It is believed to be one of the first small direct-connected turbines built for commercial use in the United States.

TT-1203

Held at 3000°F for five hours, these four brick, commonly recommended to resist high temperatures, show varying effects. Samples 1, 2, and 3 softened and slumped to different degrees, indicating loss of usefulness even below this temperature. Sample 4, a Mullfrax® electric furnace mullite refractory, is unaffected by the heat.

*fourth in a series . . .* **HEAT RESISTANCE**




# Unusual Properties of Refractory Materials

**Heat Resistance**—Exposed only to heat, Carborundum's Super Refractories can actually be used with complete safety at temperatures above 3000°F. Long before such temperatures are approached, even high heat duty and super-duty firebrick lose much of their usefulness. That's because they begin to soften several hundred degrees below their theoretical safe limits. Not so Carborundum's Super Refractories. Their strength and rigidity are maintained close to their theoretical limits.

In practice, of course, you must contend with many more conditions than heat alone. Corrosion, thermal shock, load, abrasion, erosion, etc., are usually combined with temperature. This combination of conditions may tend to lower heat resistance of refractories. That's why a refractory cannot be selected solely on its ability to withstand temperature. It also explains the reason Carborundum offers so many specialized refractories.

Heat resistance is thoroughly explored in the forthcoming issue of Carborundum's new magazine "Refractories." Send for your copy today.

**CARBORUNDUM**
Registered Trade Mark

**VALUABLE INFORMATION FOR USERS OF:**

**REFRACTORIES • CASTABLE CEMENTS • POROUS PLATES AND TUBES**

**CATALYST SUPPORTS • OXIDE, BORIDE, NITRIDE AND CARBIDE**

**HIGH-TEMPERATURE MATERIALS • CERAMIC FIBER**

***all in the new magazine "Refractories"***

**——————MAIL THIS COUPON TODAY——————**

**Dept. 176, Refractories Division**
**The Carborundum Company, Perth Amboy, N. J.**

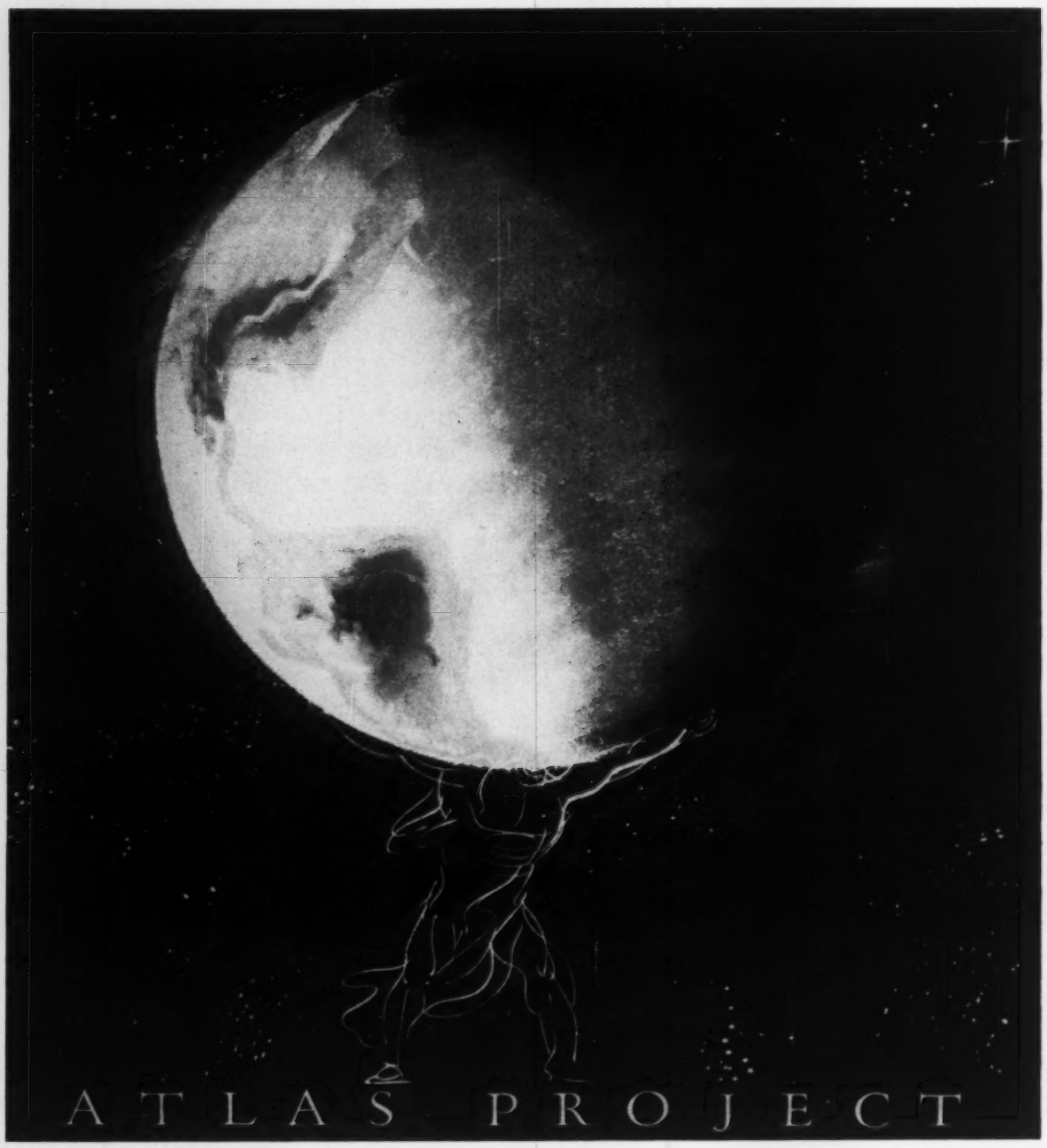
Please send me the forthcoming issue of "Refractories."

**Name**_____ **Title**_____

**Company**_____

**Street**_____

**City**_____ **Zone**____ **State**_____




Convair announces very special and immediate opportunities for experienced

**ELECTRONICS ENGINEERS** **DYNAMICS ENGINEERS**
**AERODYNAMICS ENGINEERS** **STRUCTURERS ENGINEERS**
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within a new division currently being formed for the design, development and construction of the intercontinental ballistics missile – THE ATLAS! For information concerning new engineering positions related to this tremendous project, please write at once. Address correspondence, including resume to:
Mr. H. T. Brooks, Engineering Personnel, Department 619

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GD *A Division of General Dynamics Corporation* C-V
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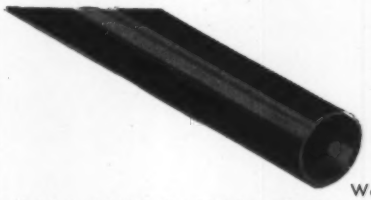


Wolverine commercial straight length tubing is available in a wide range of sizes and tempers in both copper and aluminum.

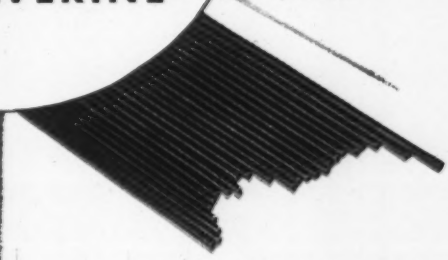
Wolverine Trufin*—the integral finned tube—boosts heat transfer performance. Available in copper, aluminum, steel and in a bimetallic form.

# YOUR BUY WORD *in Copper* ...WOLVERINE

Wolverine is equipped to make simple or complex bends to customer specifications. Other fabrication services include such operations as beading, swaging, flaring, expanding, reducing, etc.

Wolverine's Copper Spun End Process** produces one-piece tubular-shaped parts in one fast, economical operation.

Wolverine copper-to-aluminum connectors permit the use of both metals in the same refrigeration system—are available in ⅜" and ⅝" tube diameters.



Wolverine Capilator*, copper capillary tube, assures precision metering of liquids, gases and air.

Here are six copper tube ideas—each designed to do a vital job in your product—each designed to save you time and money. All of them result from Wolverine's years of metalworking experience, constant research, and the imagination of skilled engineers. All products typify creative Tubemanship in action.

When your specifications call for copper and copper-base alloy tubing and tubular-shaped parts, remember Wolverine as your "buy" word. Remember, too, that Wolverine also manufactures a complete line of aluminum tube products as well. Wolverine's General Products Catalog has the complete story. Write for your copy today.

Wolverine Tube, 1483 Central Ave., Detroit 9, Mich.

*REG. U.S. PATENT OFFICE

**A PATENTED PROCESS RE. 22485

*There is a difference in tubing and Tubemanship is that difference!*

DIVISIONS OF CALUMET & HECLA, INC.

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**WOLVERINE TUBE**

**Division of Calumet & Hecla, Inc.**

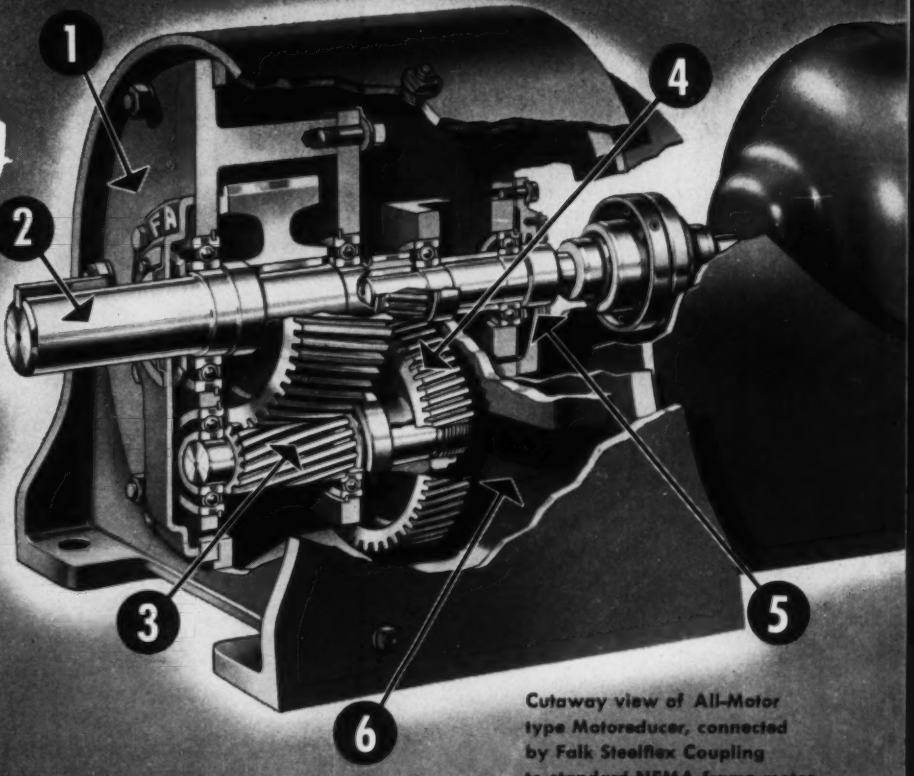
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

*Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.*

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK.

# Here's the inside story—




Cutaway view of All-Motor type Motoreducer, connected by Falk Steelflex Coupling to standard NEMA frame motor

## WHY Falk Motoreducers give better service—have longer life

Here is the "inside story" behind the all-steel All-Motor type FALK Motoreducer's universal reputation as a gear drive unmatched in quality, efficiency, dependability, ease of maintenance and long life. These "In-built" factors are—

1 **ALL-STEEL HOUSINGS.** Rugged, strong, rigid...all parts are manufactured from heavy steel plate, formed and welded in the Falk Weld Shop.

2 **LARGE OVERHUNG LOAD CAPACITY.** Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum applied loads.

3 **PRECISION GEARING.** Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion. Quiet, crown-shaved pinions.

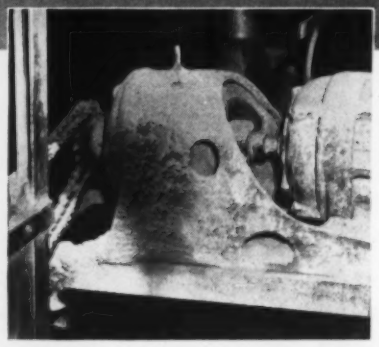
4 **EXTRA-CAPACITY GEARING.** Special extra-capacity gear-tooth form with larger contact area gives greater strength, higher load-carrying capacity.

5 **SEALED HOUSINGS.** Splashproof, dustproof, oil-tight construction. Dual closures and one-way vents keep oil in, dust and moisture out.

6 **POSITIVE LUBRICATION.** Large sump capacity...oiltight construction assures clean lubricant...revolving elements lubricated by direct dip.

When you buy or specify the All-Motor type FALK Motoreducer, you get all these—plus the tremendous advantage of full interchangeability of motors. Switch motors as desired—use any make, style or type of standard foot-mounted motor within the unit's AGMA rating—with a minimum of difficulty or "down time."

Available in sizes up to 75 hp—*with or without motor*—from convenient factory, field or distributor stocks, from coast to coast. **Write for Bulletin 3100.**



### 60,000 HOURS WITHOUT A FAILURE!

Sixty thousand hours is a lot of hours—but the FALK Motoreducer in the unretouched photo above has served that long without failure or need of repair.

This 3 hp unit is one of over 60 FALK Motoreducers in daily service in an Eastern plant of a large milling company, whose president says, in part:

"One of the main advantages of FALK Motoreducers is their adaptability to any motor. Reducers and motors can be easily interchanged.... Our service records confirm the wisdom of our choice of FALK equipment as our standard."

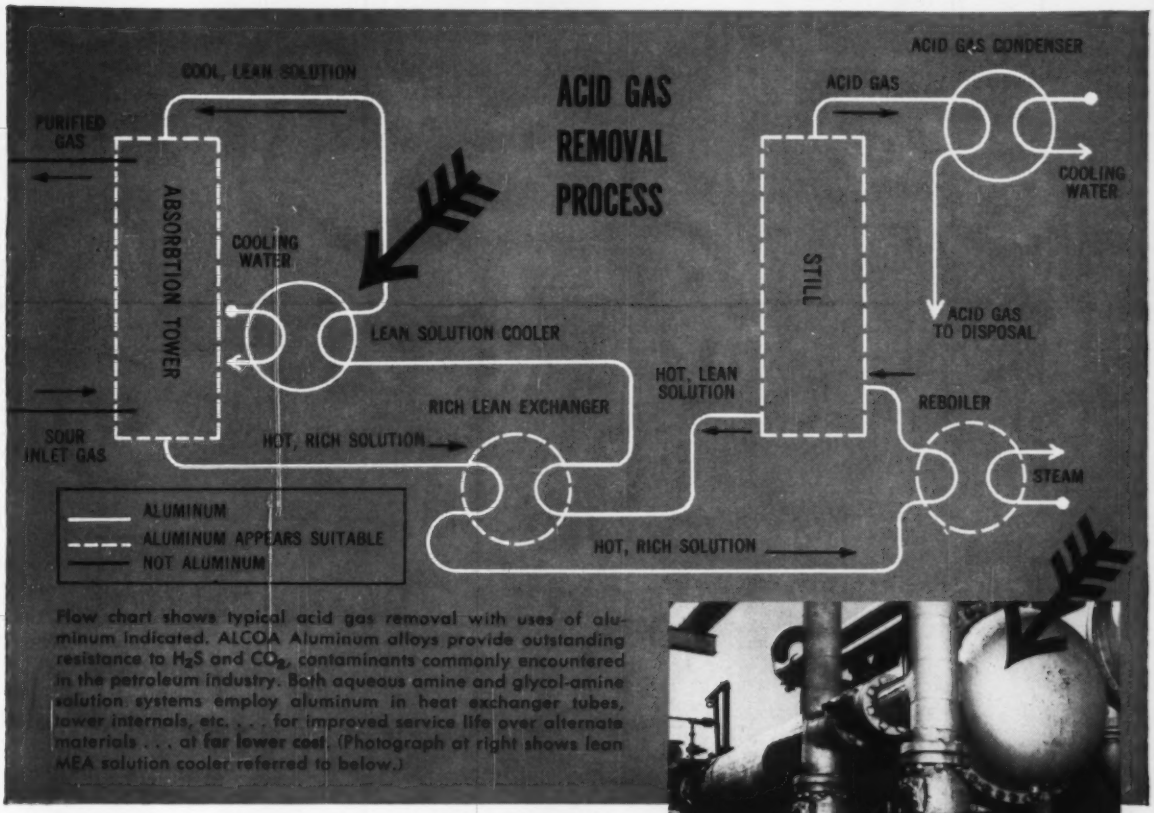
**FALK** ...a good name in industry

**THE FALK CORPORATION, MILWAUKEE, WISCONSIN**

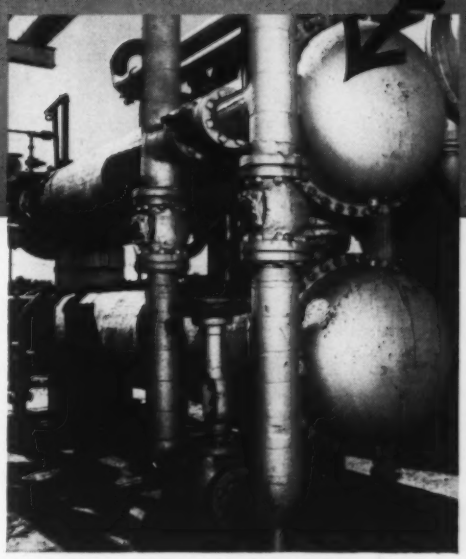
**MANUFACTURERS OF**

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

# Major oil company proves corrosion resistance of **ALCOA ALUMINUM** Heat Exchanger Tubes




Flow chart shows typical acid gas removal with uses of aluminum indicated. ALCOA Aluminum alloys provide outstanding resistance to $H_2S$ and $CO_2$, contaminants commonly encountered in the petroleum industry. Both aqueous amine and glycol-amine solution systems employ aluminum in heat exchanger tubes, tower internals, etc. . . . for improved service life over alternate materials . . . at far lower cost. (Photograph at right shows lean MEA solution cooler referred to below.)



Over 750 days' exposure to corrosive gas contaminants has proved to a major oil company the superior resistance of ALCOA Alclad Heat Exchanger Tubes. Used in the lean MEA solution cooler of a Girbotol Gas Treater, the tubes are exposed to a solution carrying 10 grains of hydrogen sulfide per gallon at the rate of 350 gallons per minute. After more than two years of service, the aluminum tubes are virtually unaffected.

Such service records have proved time and again that ALCOA Alclad Aluminum Tubes withstand corrosion best. Materials like hydrogen sulfide and carbon dioxide—normally corrosive to most metals—are not corrosive to aluminum. That means longer service life, less maintenance—to reduce process operating costs.

What's more, ALCOA Aluminum Heat Exchanger Tubes in the common sizes cost far less than seamless tubes of other common materials . . . one-half as much as Admiralty brass . . . one-third to one-fifth as much as cupronickel or stainless steel. It will pay *you* to use the handy coupon today for complete details.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

ALUMINUM COMPANY OF AMERICA
908-G Alcoa Building, Pittsburgh 19, Pennsylvania

Please send me your free 24-page booklet, Alcoa Aluminum Heat Exchanger Tubes

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Company _____

Address _____

City _____ Zone _____ State _____

# 252 LIVE-WIRE PROSPECTS*

*this could be the story of your participation in the*

# 22nd NATIONAL EXPOSITION of POWER & MECHANICAL ENGINEERING

*Under auspices of ASME*

## NOV. 26-30, 1956 — in NEW YORK'S great new COLISEUM

*252 new prospects were what just one manufacturer received as a result of his participation in the most recent Power Show. This manufacturer began exhibiting in these important expositions in 1950—with an exhibit area only 3 feet square! The outstanding sales results he has gained through his participation have prompted him to expand his exhibit area, show by show, until he now uses a 30-ft. booth.

This isn't an isolated case . . . for there are few better selling opportunities than this great exposition. And this year's Power Show will be better than ever. Held in conjunction with the ASME's annual meeting, it will attract thousands of important buying influences. Great new features—such as the expanded ATOMIC ENERGY Section—will stimulate wide interest among the thousands of engineers, production men and executives who will attend.

Perhaps equally important is the *location* of this year's exposition. Convention-going (and exhibiting) will be more convenient than ever in NEW YORK'S new, air conditioned COLISEUM (only 4 minutes from the annual ASME meetings).

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**22ND NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING**

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Our jet engines have won tremendous international acceptance. As a result, we have innumerable openings at many levels. These are career openings — not just jobs. They all offer unusual opportunities for professional growth and advancement.

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| ☐ Nuclear Design | ☐ Aerodynamics | ☐ Bearings |
| ☐ Compressors | ☐ Hydraulics | ☐ Piping |
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**Total years Mechanical Design experience** .....

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# Gilfillan pays off on ability, not adaptability

# MEMO TO EXPERIENCED MECHANICAL ENGINEERS

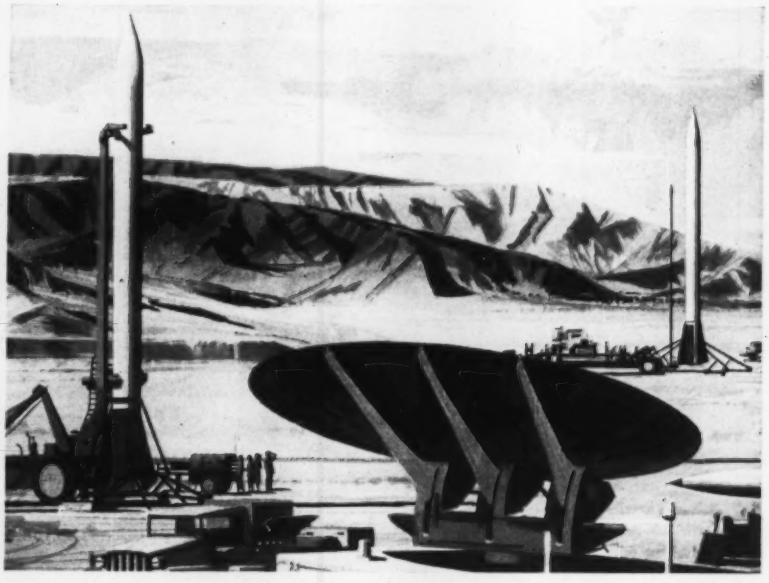
Gilfillan needs both experienced engineers and recent graduates. The significance of Gilfillan advantages will be most apparent to engineers who have experienced a static corporation system.

For example, Gilfillan does not have a rigid hierarchy of juniors, seniors, supervisors and project engineers that changes only at fixed intervals, like musical chairs.

On the contrary, Gilfillan maintains a dynamic organization, with operations under constant modification to meet current research needs. Capable engineers advance from junior to senior to supervisor to project engineer status more rapidly at Gilfillan because this fluid, changing operation means emphasis is placed on ability--rather than on adaptability to a rigid system.

Gilfillan pays higher salaries because, with emphasis on doing rather than on diplomacy, the individual is literally worth more, from the start.

You probably know Gilfillan's reputation for developing practical, simplified solutions to complete systems problems, on time. It is directly due to this Gilfillan method of operating on a basis of professional freedom, rather than under ordinary business methods.



THE ARMY'S CORPORAL: Prime contract for Basic Research and Development—Jet Propulsion Laboratory of California Institute of Technology. Prime contracts for Development (improvement and simplification of ground and airborne electronic systems); and Production (ground guidance systems and airborne electronics)—Gilfillan.

A man who stands still too long at the same job level is moving...backwards. Find out how you can move ahead--and have the satisfaction of working with whole problems, all the way through to production--at Gilfillan.

You'll want to know about other Gilfillan advantages: our patent award program, for example; tuition plan; relocation assistance; Gilfillan aid in publishing papers over your signature. About Gilfillan's record on the Corporal Guided Missile; the new Quadradar; and whatever we can tell you, under security, about our many current research and developmental prime contracts. About the growth of this 50-year-old company--number of plants, facilities, and so on.

Best way to get the answers is to write R. E. Bell, Gilfillan Bros., 1815 Venice Blvd., Los Angeles, Calif. A confidential conference will be arranged. You'll enjoy success at Gilfillan.

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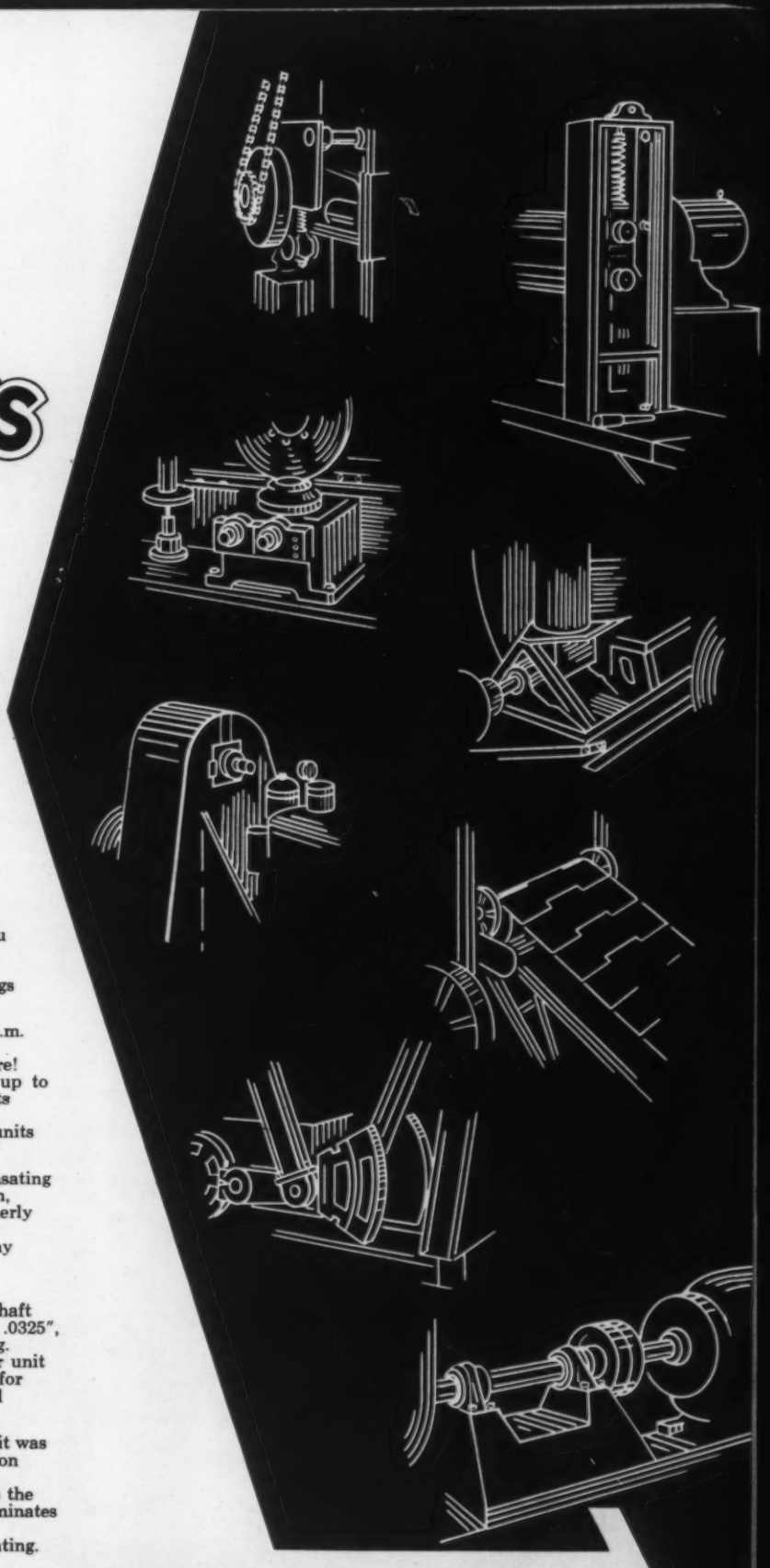
# Idea Sparkers

*for your next*

## BEARING PROBLEM



Have you ever compromised design because you had to sacrifice bearing capacity? Perhaps it was due to high operating temperatures, housing materials, or need for seals operating under extremes of dirt or water. Then you will be interested in these "idea sparkers" from designers who used Shafer Self-Aligning Roller Bearings on applications where . . .

. . . operating speeds average 3800 r.p.m. and go as high as 5000 r.p.m. 30% of the time. High temperatures? Sure! Internal bearing temperatures run up to 240°, but these Shafer Cartridge Units have proved that they can deliver the performance and are replacing all units formerly specified in the design.

. . . Micro Lock adjustment, compensating for high wear rates on one application, has added 30% to bearing life formerly experienced. This feature alone has resulted in an annual saving of many thousands of dollars in bearing replacement costs.

. . . moderate overhung load on 5" shaft caused a shaft deflection at load of .0325", resulting in severe overload at bearing. Inherent self-alignment of the Shafer unit now specified, instantly compensates for this deflection, providing the required service life and performance.

. . . size of pillow block housing on unit was working a difficult mounting restriction on the design. Better distribution of metal in the Shafer housing provides the most efficient use of metal . . . eliminates the excess bulk and unnecessary weight, solving the problem of mounting.

*TURN THIS PAGE FOR MORE INFORMATION*

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*LEADERSHIP . . . through creative engineering*

**IDEA SPARKERS** *(CONTINUED)*

... an advantage was found by another manufacturer for itself as well as its customers. Because of the interchangeability of Shafer components, parts stocking became an easier, less expensive job. Shafer Bearing Division is the only bearing manufacturer that offers this feature.

# SHAFER

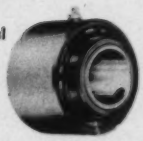
**Self-Aligning Roller Bearings**

**Offer More Capacity — Positive Sealing — Self-Alignment — Housing Strength for All Applications**

Pillow Blocks: Normal and Heavy Duty from ¾" to 7" shaft sizes, 2 and 4 bolt base types. Also, expansion type and adapter mounting units.

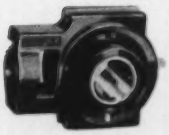
Flange Cartridge Units: Normal and Heavy Duty from ¾" to 5" shafts. Bore tolerance of mountings — plus .002", minus .000".

Flange Units: Normal and Heavy Duty from ¾" to 5" shaft sizes. Also available with a flange pilot.

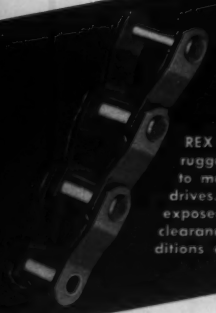


**Cartridge Units: Normal and Heavy Duty from ¾" to 7" shafts. Cartridge housing drilled and tapped for lubricating fitting.**

**Take-Up and Frame Units: Normal, Heavy and Extra Heavy Duty from 1-15/16" to 4-7/16". Special reinforcements for greater capacity.**



**Take-Up Units: Normal and Heavy Duty from ¾" to 4" shafts. Guide slots milled for sufficient clearance to operate on hot-rolled guide bars.**



REX ASA ROLLER CHAINS ... precision-built chains for moderate to high-speed drives. Exclusive pitch control system assures longest possible service life.

REX CHABELCO STEEL CHAINS ... rugged, heavy-duty chains for slow- to moderate-speed, heavy-load drives. Ideal for operation in exposed conditions ... built-in clearances permit operation in conditions of dust and dirt.

**REX OFFSET SIDE BAR ROLLER CHAINS combine the high-speed service features of ASA roller chain with the strength and flexibility of Chabelco Chains.**

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# Pumping Progress Report

**FOR MECHANICAL ENGINEERS**

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

SPACE, in many pump installations, is a major problem. Another is the necessity for special foundations. When new installations are considered, these factors may dictate more elaborate construction than should be necessary. And for replacement or modifications of existing systems, they may require expensive piping and equipment changes.

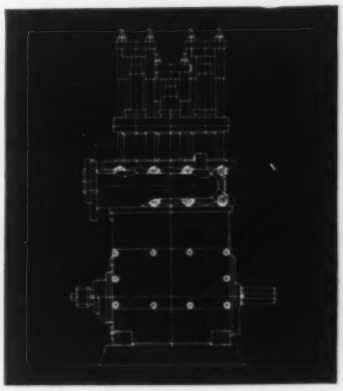
COMPACTNESS OF DESIGN, while often desirable, is not necessarily the answer. Simplicity of design — as in the case of ALDRICH Direct Flow Pumps — may be a better solution.

SIMPLICITY OF DESIGN brought about the first inverted Triplex and Quintuplex Pumps and ultimately Septuplex and Nonuplex Pumps. This Aldrich design innovation brought to pump users many economies of space, maintenance and operation they had never known.

INVERTED PUMP DESIGN permits the use of less expensive foundations. With the crankshaft located near the floor there is no need for expensive foundation work to raise the driver or lower the pump. Then, too, inverted pumps require fewer square feet of floor space than conventional pumps.

MAINTENANCE COSTS ARE REDUCED. Fluid-end, where most work is done, is at chest level. Bearing replacements are made without removing heavy crankshafts or connecting rods. Crossheads on all Direct Flow Pumps can be worked on or removed from pump without disturbing fluid-end.

TELL US ABOUT YOUR PUMPING PROBLEM. The chances are that one of our standard pumps — or a modification of one — will do your job. Detail your problem and we'll send you a copy of the Data Sheet that describes the Direct Flow Pump we recommend. Write to: The Aldrich Pump Company, 29 Pine Street, Allentown, Pa.



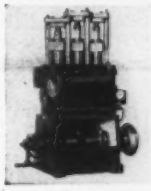
Aldrich inverted vertical pump design

**. . . for your tough pumping problems specify ALDRICH**

The entire line of Aldrich Direct Flow Pumps feature two outstanding design innovations—inverted vertical design and sectionalized fluid-ends. These two features have helped make Aldrich the organization hydraulic engineers turn to when they face tough pumping problems. If you have a pumping problem, turn it over to the men who have never turned down a challenge.

**CHECK THESE ADVANTAGES OF INVERTED PUMP DESIGN:**

**Smaller Foundations**
**Simpler connection with prime mover**
**Less floor space required**
**Reduced maintenance costs**



*Write today for Data Sheets describing the Direct Flow Pump Series.*

**THE ALDRICH PUMP COMPANY**

**Originators of the Direct Flow Pump**
**29 PINE STREET**
**ALLENTOWN, PA.**
*Representatives in principal cities*

# If you're not in the book *you're a man without*

. . . . . a country
. . . . . a state
. . . . . a county
. . . . . a town
. . . . . a party
. . . . . a street
. . . . . a school
. . . . . a *vote*

Look at all the things you can lose, if you're not a registered voter.

If you're not in the book, you lock yourself out of the elections. The polls are closed to you. You can't vote on streets, or schools, councilman or mayor (not to mention congressman, senator or president). You don't even have the right to *complain* about your government and the way things are run!

But more than that, you cut yourself apart from your neighbor next door, your friends at the shop, your fellow members in union or club.

You lose the right to look that boy of yours in the eye when he wants to know if you're doing your part.

And you lose the self-respect that comes from knowing you can walk into the polls on Election Day—the one place in the world where all free men are really equal. Isn't it too much to risk for the little time that registering takes?

Get your name in the book
—and do it now!

## *Is your name in the book?*

# WHO

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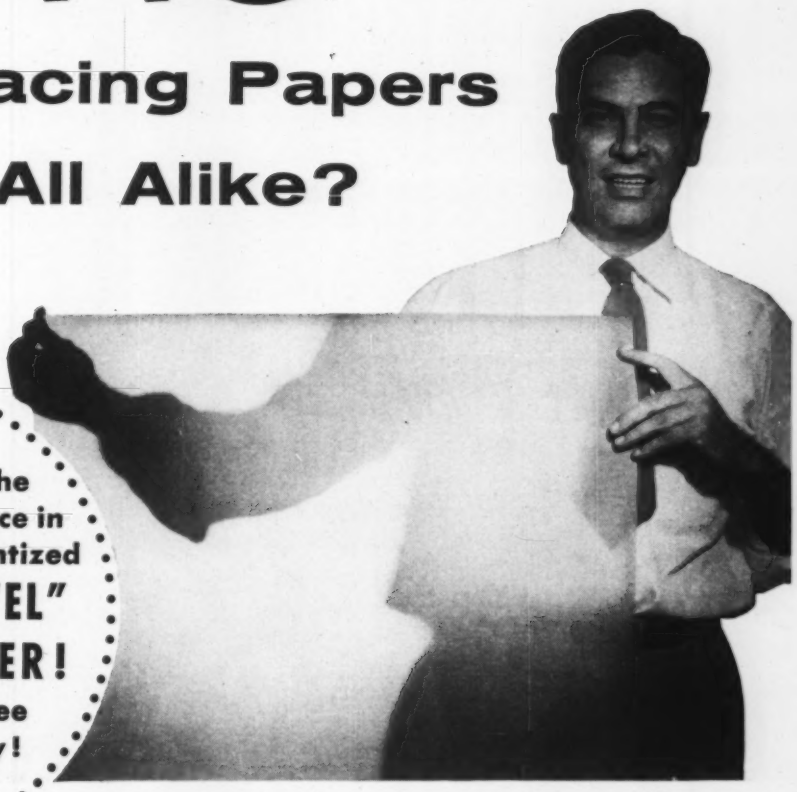

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**And for a Wonderful Difference in a Smooth Surface Paper, try . . .**

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# Boeing's new Mach 4 tunnel: a vital step in the engineering art

Typical of Boeing's superb facilities, this new supersonic wind tunnel will lead to important mechanical engineering advances. It is capable of producing velocities four times the speed of sound, and will be teamed with Boeing's present transonic tunnel for a research facility that will be the most advanced and versatile of its kind in private industry.

The knowledge of mechanical engineers is important in determining the configurations to be tested in the new tunnel. The tunnel will enable them to test new structural components and materials under the extreme conditions of hypersonic flight, as well as in the transonic zone. Mechanical engineers at Boeing are also important in structural and flight testing, in mechanical and structural design, in jet, rocket and ram jet propulsion, and many other fields.

In addition to the new tunnel, engineers find other advanced facilities at Boeing: the latest electronic computers, a chamber that can simulate altitudes up to 100,000 feet, a new multi-million-dollar Flight Test Center, and many more. This is evidence of Boeing's steady growth. The company now employs more than twice as many engineers than at the peak of World War II—and more engineers are needed.

Engineers who come to Boeing will find stimulating work, at the very frontiers of engineering knowledge. They will find individual recognition and opportunity for advancement in small, tightly integrated "teams" in research, design or production. And they and their families will enjoy living in the pleasant and progressive community of Seattle or Wichita. There may be a place for *you* in this challenging world of tomorrow at Boeing-Seattle or Boeing-Wichita. Won't you write and find out today?

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**Edward Valves**

Large size knobbed handwheel eases operation.

Deep, full-size stuffing box and Evalpack packing combine to minimize maintenance.

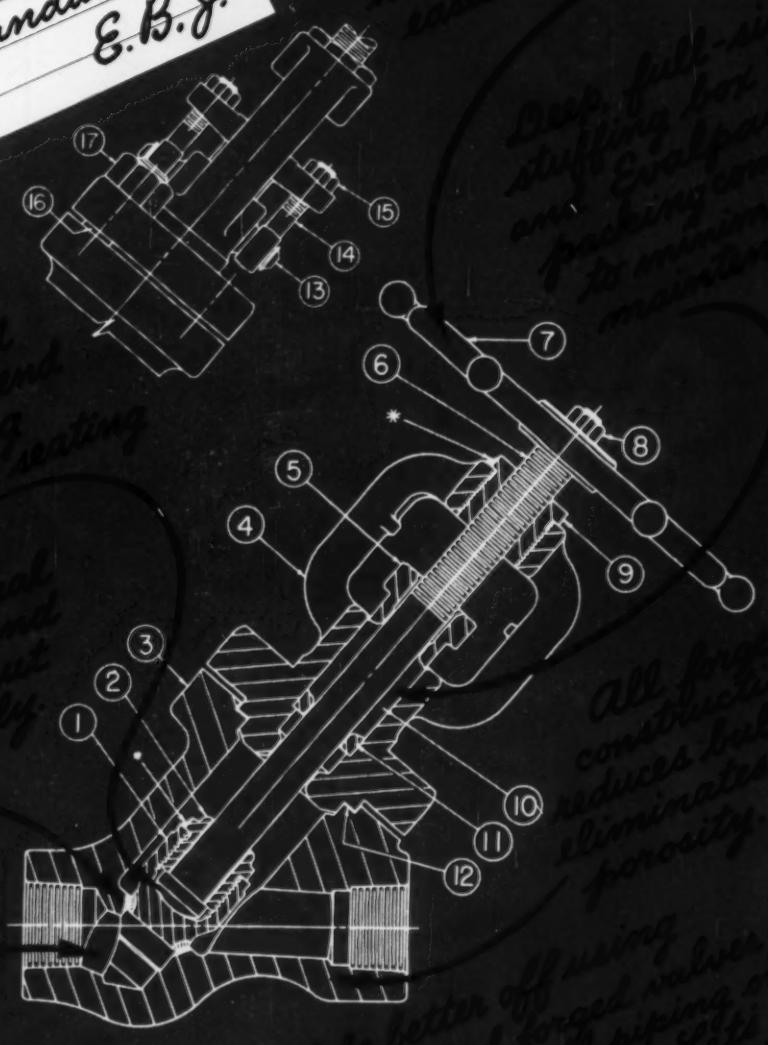
Swivel disk and radiused stem end prevent galling insure perfect seating

Edward integral Stellited seat and Stellited disk cut repairs sharply.

Straight through flow minimizes turbulance and pressure drop.

All forged construction reduces bulk-eliminates porosity.

We'll be better off using Edward forged valves for all small piping on our job. Let's get a bid.

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WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

| PIECE NO. | NAME OF PIECE | NO. REQ'D | MATERIAL | SPECIFICATIONS | EDWARD MS NO. |
|---|---|---|---|---|---|
| 1 | DISK | 1 | FORGED ALLOY | A.S.T.M. A182 GRADE F11 | 227 |
| | | | STEEL STELLITED | | 483 |
| 2 | DISK NUT | 1 | STEEL | A.I.S.I. C1120 | 123 |
| 3 | BODY | 1 | FORGED STEEL (a) | A.S.T.M. A105, GRADE II | 111/483 |
| | | | FORGED STEEL (b) | A.S.T.M. A182, GRADE F11 | 227/483 |
| 4 | BONNET | 1 | FORGED STEEL (a) | A.S.T.M. A105, GRADE II | 111 |
| | | | FORGED STEEL (b) | A.S.T.M. A182, GRADE F11 | 227 |
| 5 | GLAND | 1 | MALLEABLE IRON | A.S.T.M. A220, GRADE 53004 | 324 |
| 6 | STEM | 1 | EVALLOY | A.I.S.I. GRADE 416 | 261 |
| 7 | HANDWHEEL | 1 | MALLEABLE IRON | A.S.T.M. A47 GRADE 32510 | 322 |
| 8 | STEM NUT | 1 | STEEL | A.S.T.M. A194 - GRADE 1 | 124 |
| 9 | YOKE BUSHING | 1 | BRONZE | A.S.T.M. B62 | 412 |
| 10 | PACKING RINGS | | EVALPAK | HIGH TEMPERATURE PACKING | 501 |
| 11 | JUNK RING | 1 | STEEL - EVALIZED | A.I.S.I. C1120 | 123 |
| 12 | BONNET GASKET | 1 | IRONKOTE | | 505 |
| 13 | GLAND BOLT WASHER | 2 | STEEL | | |
| 14 | GLAND BOLT | 2 | FORGED STEEL EVALIZED | A.S.T.M. A105, GRADE II | 111 |
| 15 | GLAND BOLT NUT | 2 | STEEL - EVALIZED | A.S.T.M. A194 - GRADE 0 | 125 |
| 16 | TAP END STUD | 4 | ALLOY STEEL (c) | A.S.T.M. A193 | |
| 17 | BONNET STUD NUT | 4 | STEEL (c) | A.S.T.M. A194 - | |

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SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

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GLOBE AND ANGLE VALVES

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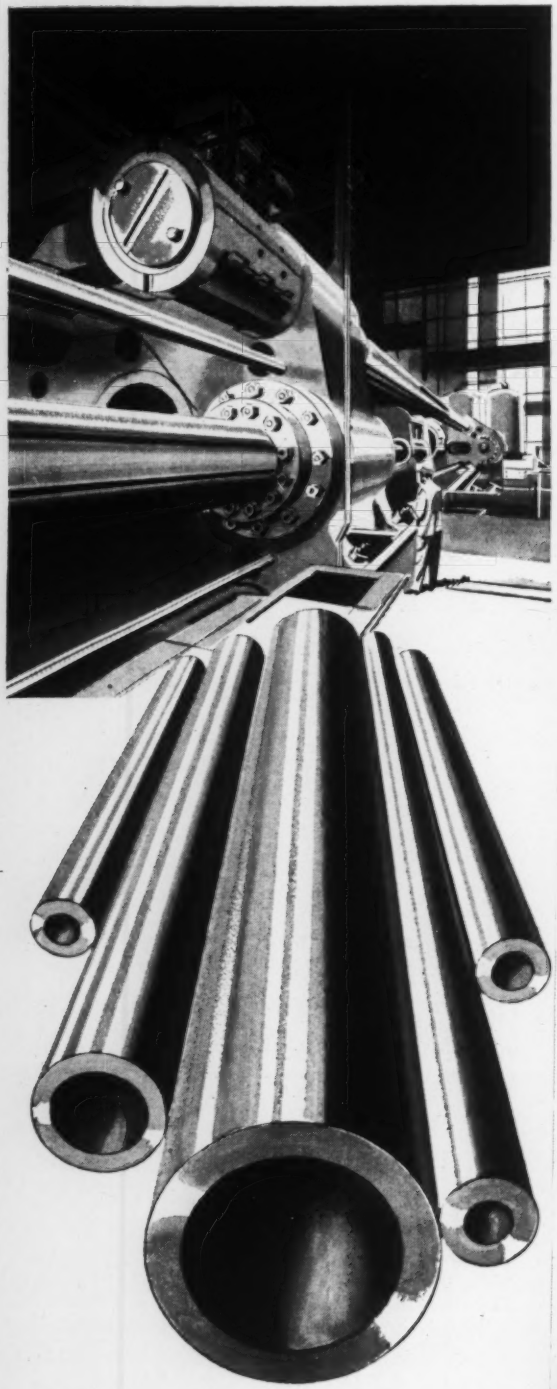
| CHK'D [illegible] | | AE-3529-2 |
| APP'D [illegible] | DATE [illegible] | |

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

# NOW! from the world's largest horizontal steel extrusion press...



## SEAMLESS

# HEAVY WALL PIPE

## from any ferrous alloy

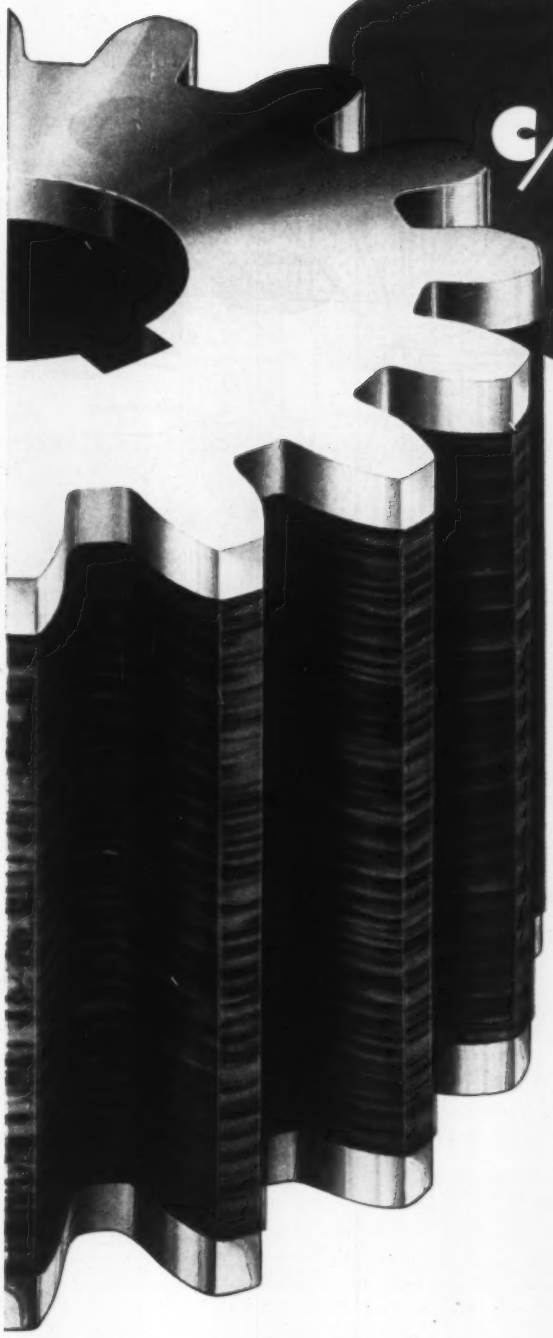
Now heavy wall pipe can be extruded from any ferrous alloy — in lengths up to 50 feet or more, with O.D.'s from 4″ to 22″, and with virtually no restriction on wall thickness.

The giant Curtiss-Wright horizontal extrusion press, now operating at the Metals Processing Division, *moves* the metal instead of *removing* it, for pipe of maximum length — and strength.

If your application calls for higher heat, corrosion and/or abrasion resistance — in pipe of highest tensile and yield strengths — Metals Processing Division is geared to fill the requirement. Complete facilities for handling any ferrous alloy, including the stainless series, as well as titanium and other reactive metals, are available to the chemical, petroleum, power and other key industries.

Take advantage of this new, aggressive facility for your pipe requirements. Write, wire or telephone for detailed information or engineering consultation today. Our field engineers are at your service.

METALS PROCESSING DIVISION
CURTISS-WRIGHT
CORPORATION • BUFFALO, NEW YORK



# Do you know what C/R RAWHIDE GEARS can do for you?

**HERE'S WHAT**—They will transmit power quieter, with less vibration than other types of gears. These tough, resilient Rawhide gears will absorb momentary overloads up to 3 times their rated H.P. capacity . . . protecting expensive metal gears. Since C/R Rawhide pinions cause negligible wear, they actually prolong the life of mating metal gears.

**MORE FACTS**—They require no lubricant, are nonconductors, and are extremely durable. Rawhide spur gears are cut in sizes from 1″ O.D., ¼″ face up to 30″ O.D., 12″ face. D.P.'s range from 48″ to 1¼″; horsepower ratings go up to 50 H.P. or more. Where high temperature and humidity are factors, C/R gears cut from Nylon, Fabroil, Bakelite, or Micarta may be more suitable.

**ASK C/R**—We've been cutting non-metallic spur, helical and bevel gears for all types of applications for over 74 years. May we help solve your gear problem?

*Please write for illustrated C/R Gear Booklet.*

GEAR C/R DIVISION

CHICAGO RAWHIDE

**CHICAGO RAWHIDE MANUFACTURING COMPANY**
1229 Elston Avenue • Chicago 22, Illinois

Offices in 55 principal cities. See your telephone book.

In Canada: Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario
Export Sales: Geon International Corp., Great Neck, New York

**Other C/R Products**
C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots

# NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

## Industry's First Private Research Reactor Now in Operation

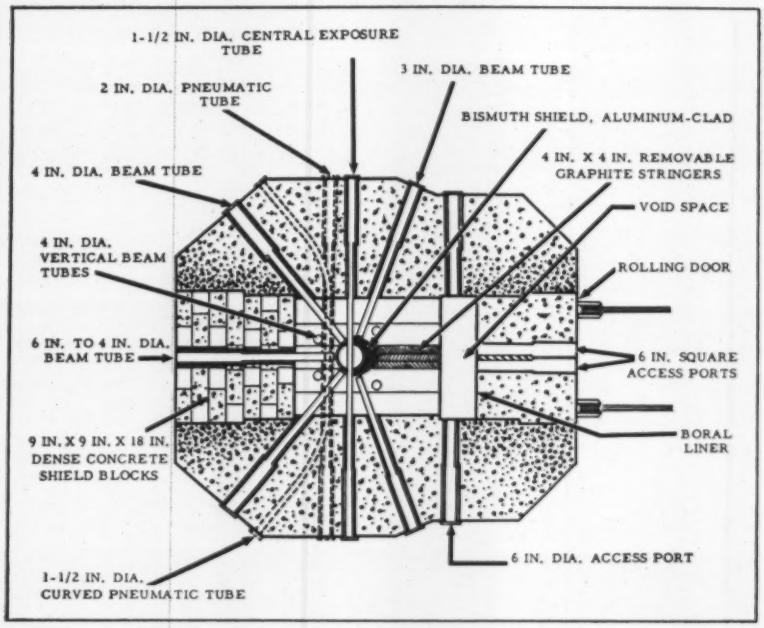
The Armour Research Foundation's nuclear reactor, located on the Illinois Institute of Technology Campus on State Street near Chicago's Loop, began operating early this spring. This marked the first time that private industry has had at its disposal a nuclear reactor expressly designed for industrial research.

**Already under way** at Armour are programs by participating companies, taking advantage of the revolutionary research techniques made possible by the new facility. The schedule includes allocation of reactor "time" for private studies, free of security restrictions. Areas of study include: food and drug processing; materials research – glass, ceramics, plastics, rubber, textiles, etc; petroleum, chemicals and other industrial materials and processes.

The Model L8 Armour reactor is of the homogeneous solution type, designed to operate at 50 KW and to produce a maximum thermal neutron flux of about $1.7 \times 10^{12}$ neutrons/cm$^2$-sec at the center of the reactor core. Exposure facilities are provided through which the neutron flux is available in varying intensities for experimental purposes. Power level is controlled either manually or automatically by a vertical control-rod system. The reactor is safeguarded by a unique control system which "scrams," or automatically shuts down the reactor, if necessary.

**One of several reactors** produced by ATOMICS INTERNATIONAL, a Division of North American Aviation, Inc., the design and construction of the L8 Model is based on the company's 10 years' experience in the development of peaceful applications of nuclear energy. Other applications include a reactor designed for a prominent southern California university, specially adapted for cancer and other medical research; the important Sodium Reactor Experiment in the Santa Susana Mountains near Los Angeles, part of the AEC program to develop economical power from nuclear energy; plus development and design of a 75,000 KW sodium-graphite nuclear power plant.

ATOMICS INTERNATIONAL is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power.


1-1/2 IN. DIA. CENTRAL EXPOSURE TUBE
3 IN. DIA. BEAM TUBE
2 IN. DIA. PNEUMATIC TUBE
BISMUTH SHIELD, ALUMINUM-CLAD
4 IN. DIA. BEAM TUBE
4 IN. X 4 IN. REMOVABLE GRAPHITE STRINGERS
VOID SPACE
4 IN. DIA. VERTICAL BEAM TUBES
ROLLING DOOR
6 IN. TO 4 IN. DIA. BEAM TUBE
6 IN. SQUARE ACCESS PORTS
BORAL LINER
9 IN. X 9 IN. X 18 IN. DENSE CONCRETE SHIELD BLOCKS
6 IN. DIA. ACCESS PORT
1-1/2 IN. DIA. CURVED PNEUMATIC TUBE

Reactor Plan View

**ARMOUR RESEARCH REACTOR MODEL L8**

**Characteristics**

| | |
|---|---|
| Design Power | 50 kw |
| Zero Power Critical Mass* | 850 gm $U^{235}$ |
| Maximum Thermal Neutron Flux | $1.7 \times 10^{12}$ n/cm$^2$-sec |
| Mass Coefficient of Reactivity* | 0.03%/gm |
| Temperature Coefficient of Reactivity* | —0.029%/°C |
| Fuel Solution Temperature at 50 kw* | 80° C |
| Excess Reactivity at 20° C, Zero Power* | 3% |
| Reactivity Held in Control and Safety Rods* | 8% (2% each rod) |
| H : $U^{235}$ Atomic Ratio* | 350 |
| $U^{235}$ Concentration* | 75gm/liter |
| Power Density, Maximum | 5.5 watt/cm$^3$ |
| Power Density, Average | 3.85 watt/cm$^3$ |

*Approximate Value*

**Brief General Description**—The reactor fuel is a light water solution of $UO_2SO_4$, enriched in $U^{235}$. This fuel is contained in a spherical stainless steel core tank, which is surrounded by a graphite reflector. The reactor is shielded with high density concrete (density 3.5 gm/cm$^3$) plus other selected materials. Fuel-handling, gas-handling and cooling systems are provided; also complete instrumentation and equipment are installed for remote operation and to provide automatic safety action.

**Experimental Facilities**—The experimental facilities include nine assorted beam tubes, 3" to 6" ID; straight and curved pneumatic tubes, 1½" and 2" ID; central exposure tube; horizontal thermal column 5' square, with four 6" access ports. In addition there are special exposure facilities which make use of the gamma activities in the reactor atmosphere.

**If you are interested** in any phase of our activities, ATOMICS INTERNATIONAL is staffed and equipped to help you. Please write: Applications Engineering Service, Dept. ME-N3, ATOMICS INTERNATIONAL, P. O. Box 309, Canoga Park, California. Cable address: ATOMICS.

**ATOMICS INTERNATIONAL**

A DIVISION OF NORTH AMERICAN AVIATION, INC.

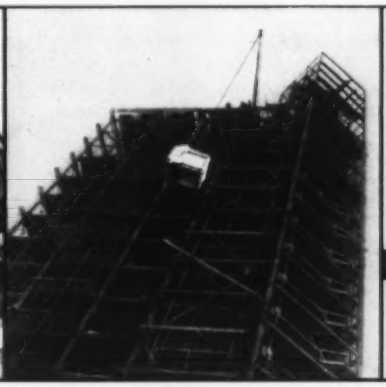
PIONEERS IN THE CREATIVE USE OF THE ATOM

# You can put a VP boiler ANYWHERE!

**Life and Casualty Tower** will be the tallest commercial structure in the southeastern United States. It contains 30 floors plus basement, observation platform and a three-story penthouse containing the mechanical equipment—including two VP package boilers. The building is scheduled for occupancy in January, 1957. It is owned by Life and Casualty Insurance Company of Tennessee.

*. . . anywhere the floor-loading's adequate, of course. In Nashville's nearly-finished Life and Casualty Tower, two Combustion Engineering Package Boilers, Type VP, were installed in a 32nd-floor penthouse — nearly 400 feet above the street. The pictures show how the job was done.*

**Take It Away**—First of two VP Boilers—27,000 pounds—clears the truck bed in the first step of its 32-story journey. VP Boilers come fully assembled, ready for water, rail or road shipment anywhere in the world.



**Almost Home**—This VP has probably shattered the altitude record for boilers now—and it has another 30 or 40 feet yet to go. That's one of the advantages of the VP. You pick the spot and the rigging boys will find a way to move it in.

**Boiler in a Penthouse**—Now it's almost settled in its permanent skytop home; about set to bring up number 2. When the floor is ready, they'll hook up fuel, water and the job's done. They'll burn gas in these boilers, with oil as stand-by.

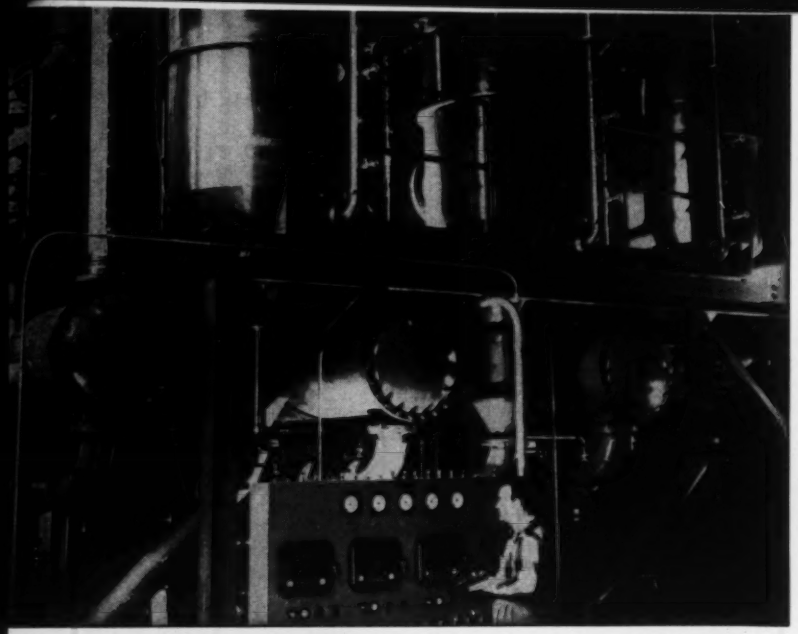
The completely shop-assembled VP Boiler, shown at left, is available in fourteen sizes from 4,000 to 40,000 lb steam per hr ... for operating pressures up to 500 psi ... for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The larger lower drum—30-inch diameter—permits a simple, symmetrical tube arrangement ... greater water storage capacity ... easy access for washing down or inspection. A low speed centrifugal fan which is exceptionally quiet in operation is standard equipment. The simple baffle arrangement results in low draft loss ... simple soot blowing ... no dead pockets ... high heat absorption. The VP is enclosed in a reinforced, gas-tight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, the VP Boiler requires only a simple concrete slab.

C-E **COMBUSTION ENGINEERING**

B-928A

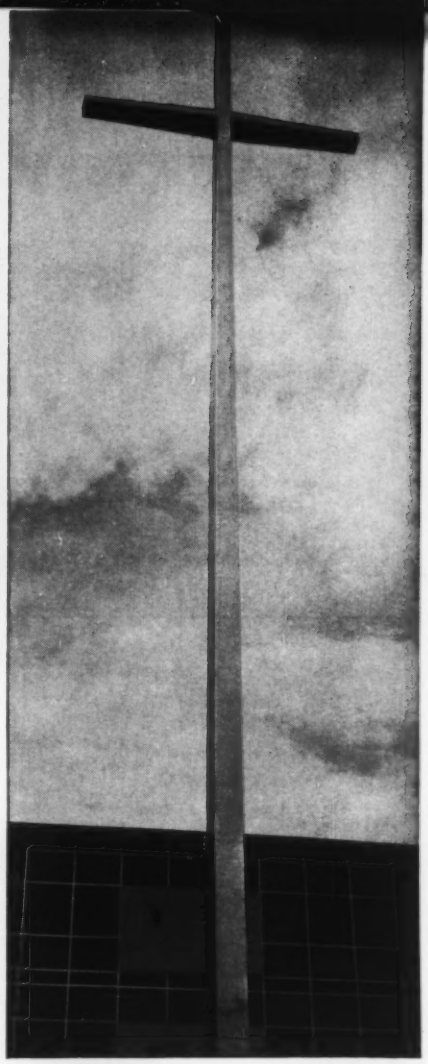
**Combustion Engineering Building • 200 Madison Avenue, New York 16, N.Y.**
**Canada: Combustion Engineering-Superheater Ltd.**

Steam Generating Units • Nuclear Reactors • Paper Mill Equipment • Pulverizers • Flash Drying Systems • Pressure Vessels • Home Heating and Cooling Units • Domestic Water Heaters • Soil Pipe



**FOR CORROSION RESISTANCE.** The Marathon Corporation developed a method of producing lignosulfonates from paper mill sulfite liquor, but it was impractical until Stainless Steel became available in the 1930's. The plant now produces 75 million pounds a year, and 50% of the equipment is Stainless Steel.

# NOTHING *can equal* Stainless Steel



**FOR ENDURING BEAUTY.** This great religious symbol is erected on the grounds of St. Patrick's Academy, Chicago, Ill. The Stainless Steel skin furnishes a gleaming, permanent inspiration to all viewers.

• No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When buying Stainless, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

**FOR WET, ABRASIVE SERVICE.** Here's a Stainless Steel shaker screen in a coal plant. Management says, "Ordinary screens would only last about two weeks, but we can expect three *years* of service from these Stainless Steel screens . . . "

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
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## USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS
PIPE • TUBES • WIRE • SPECIAL SECTIONS

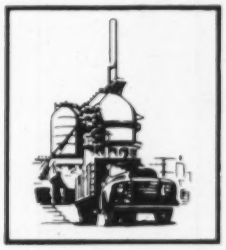
USS

**UNITED STATES STEEL**

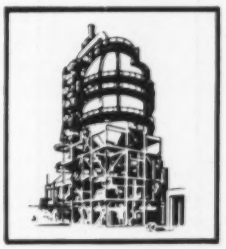
This "OGRE" can ruin a hot underground piping system that is turned on and off!
Let's look beyond just the initial cost of installing an underground piping system!
Consider for a moment how this system, once installed, will react to the thermal shock of turning it *on* and *off* (and what system isn't turned *on* and *off* occasionally). Unless the system is inherently capable of withstanding the shock of *on* and *off* service . . . that's when the "Ogre of Corrosion" swiftly becomes a real threat . . . and it costs *you* money!
Ask your Ric-wiL representative to explain how a Ric-wiL system protects you against *on* and *off* thermal shock.
Write for the *NEW* Ric-wiL Catalog or phone your Ric-wiL representative for a copy.
RIC-WIL
*Quality Piping Systems . . .*
*. . . of Exceptionally High Thermal Efficiency*
RIC-WIL INCORPORATED
PREFABRICATED INSULATED PIPING SYSTEMS
BARBERTON, OHIO
Representatives In Principal Cities

# ONE SOURCE *for all Three*

ENGINEERING



MATERIALS



ERECTION SERVICE

If you are revamping or adding to the capacity of cat crackers, oil stills or heaters—you'll do better if you get a quote from Bigelow-Liptak on the refractories for the vessel or heat enclosures.

Why? Because B-L supplies all of the *three* elements which must be considered—engineering, materials, erection help.

Jobs are handled by engineers who *know* every facet of the problem at hand—men who have had years of experience with refractories and oil refinery problems. Materials used have been proven on countless installations under the most severe of abrasive or high temperature conditions. And erection is performed by a crew of men who specialize in refinery work . . . not only in the United States, but all over the world.

All in all, you can't miss. Cost? Less than you might think—particularly in the long run. Write today!

**BIGELOW-LIPTAK** *Corporation*

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**UNIT-SUSPENDED WALLS AND ARCHES**

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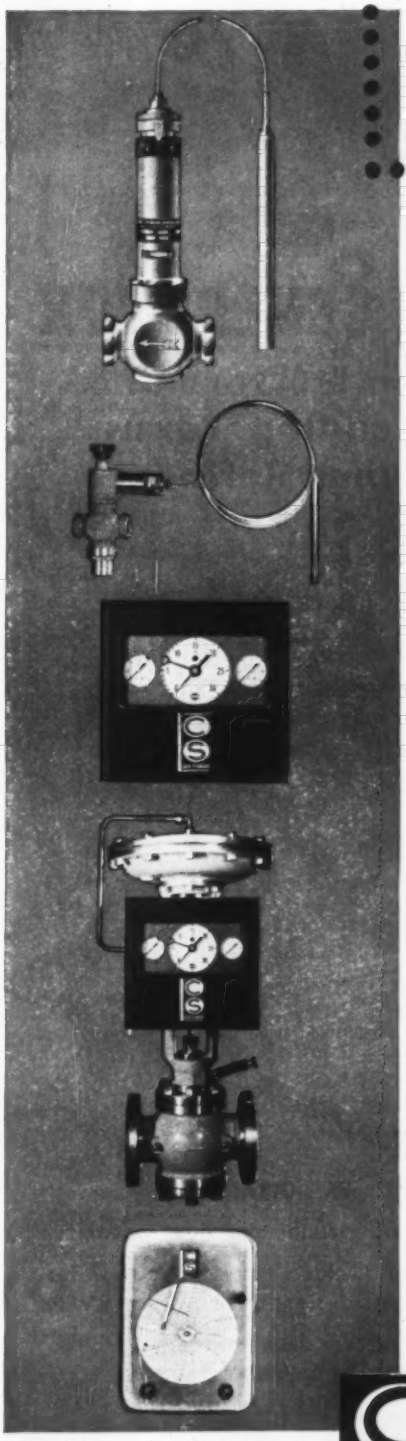

# For Accurate, Reliable Temperature Control

## STACON V SERIES
### Self Operating Temperature Regulators—

Feature a liquid filled thermal system for high operating power and uniform throttling action and has built-in over-load protection. Available in 50°F. and 100°F. ranges from 25° to 325°F. Direct and reverse acting units ¼" to 1½" with screwed ends, and 2" to 4" with flanged ends. Bulletin No. 500. (Cash Standard Stacon Corp.)

## STACON TYPE VS
### Temperature Safety Regulators—

Used in the supply steam or gas line and will protect a process by snapping shut when the process temperature goes above a desired temperature level. Easily adjustable and remains closed until manually reset. Available in sizes from ½" to 1½" with screwed ends. (Cash Standard Stacon Corp.)

## CASH STANDARD TYPE 51
### Indicating Controllers—

An air operated, mercury actuated proportional temperature controller. Temperature ranges from —40°F. to 1000°F. Calibrated set point adjustment, unit construction, air relay with sapphire orifice and push button cleaner, feedback type proportional control with 1-100% band and differential gap. Also available with 1-150% proportional band combined with automatic reset action. Bulletin No. 978. (A. W. Cash Co.)

## CASH STANDARD TYPE 30
### Diaphragm Control Valve (With Type 51 Mounted)

A rugged, dependable control valve—available in sizes ½" to 12" with various styles of inner valves—reverse or direct acting. Accurate control is assured when the Type 30 is used with 51 or 57 controllers, valve mounted as illustrated, or where the controller is installed remotely. Bulletin No. 980. (A. W. Cash Co.)

## CASH STANDARD TYPE 57
### Recording Controllers—

An air operated temperature controller with mercury, vapor, gas or organic liquid actuation. Temperature ranges from —350°F. to 1200°F. Available in 9" and 12" case size, spring or electric driven chart drive, on-off control or 1-100% proportional control.

All units have push button nozzle cleaner; proportional controllers also have sapphire jewelled relay orifice with push button cleaner. Bulletin No. 979. (A. W. Cash Co.)

**WHAT'S *YOUR* TEMPERATURE CONTROL PROBLEM?**

**Cash Standard and Stacon have the answer or will find one.**

**Contact the Cash Standard temperature and pressure control specialist in your area, or write Dept. C**

**CASH** C S **STANDARD**

**A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.**
**P. O. Box 551, Decatur, Ill.**

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

# THIS 400,000 Pounds per HOUR

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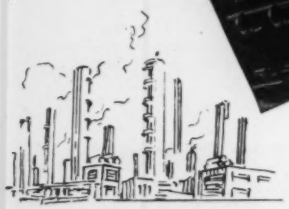
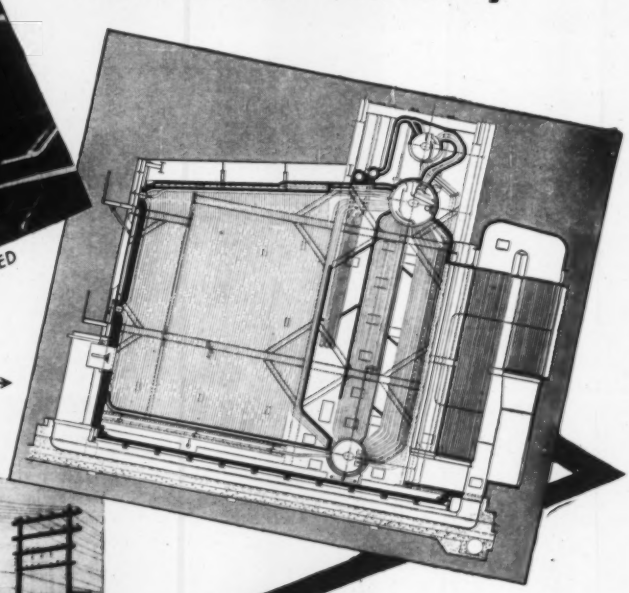
## STEAM GENERATOR

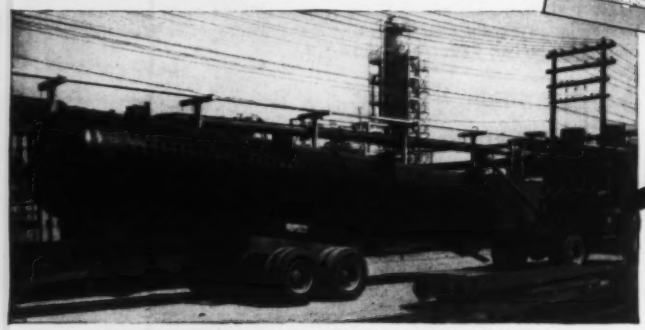
### Gives Top Performance in a Leading Texas Petroleum Refinery

VIEW OF THE COMPLETED STEAM GENERATOR



RIGHT →
LONGITUDINAL SECTION THROUGH THE UNIT.





6'-6" DIAMETER x 37'-0" LONG STEAM DRUM BEING TRANSPORTED TO THE ERECTION SITE DURING INSTALLATION.

**PRINCIPAL DATA**

400,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 700 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Oil and Acid Sludge fuel.

Vogt builds a complete line of bent tube steam generators designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Write for bulletins.

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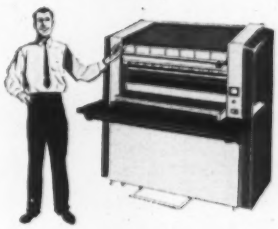
**SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, Cincinnati, St. Louis, Dallas, Charleston, W. Va., San Francisco**

## You Need It!

The boom in production means more pressure than ever for engineering prints. A new, modern reproduction unit with higher speeds, more operator conveniences will help you deliver them.

## You Want It!



Take this opportunity to replace that old, inadequate reproduction machine with the efficient new unit you've been wanting—a faster, better engineered, and trouble-free *modern* machine!

## You'll Surely Get Management Approval!

If your firm, like most, is gearing up for greater-than-ever production, you couldn't pick a better time to get the approval of management for new, modern, higher-production equipment.

# NOW Is the Time to Get Your New, Modern Bruning Copyflex Machine!

To meet production's push for more engineering prints, you couldn't pick a better time to get a new, modern reproduction machine. And you couldn't make a wiser choice than efficient, trouble-free Copyflex!

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!

**COPYFLEX MODEL 500**—A new, ultra-fast, heavy volume machine offering top mechanical speed of 40 f.p.m., automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features.

**BRUNING** Copyflex

Best Process! Best Machines!
Best Selection of Materials!

*Specialists in Copying Since 1897*

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**4700 Montrose Ave., Chicago 41, Illinois**

Please send me information on Copyflex process and Model 500 Machine.

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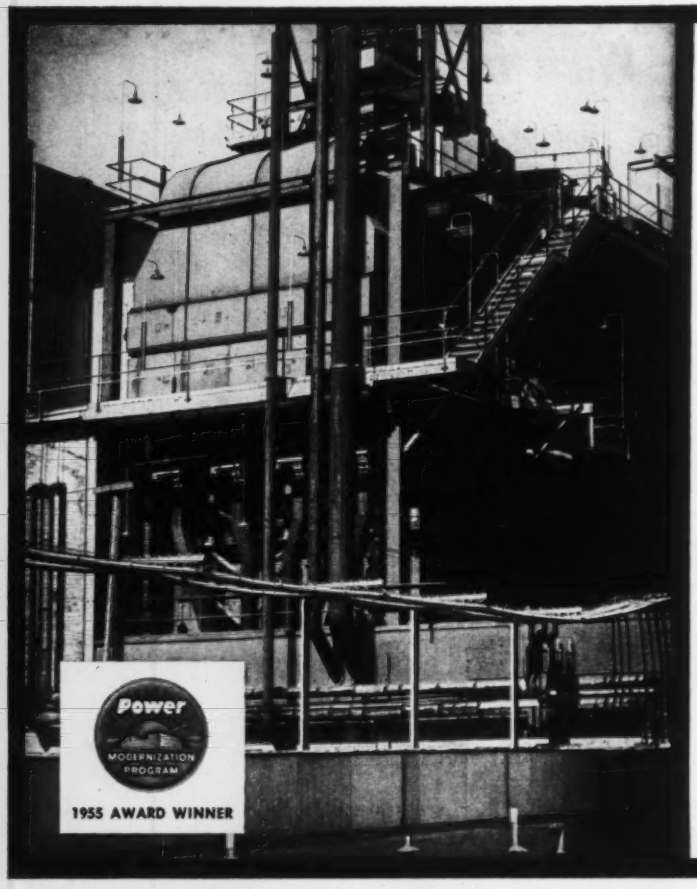
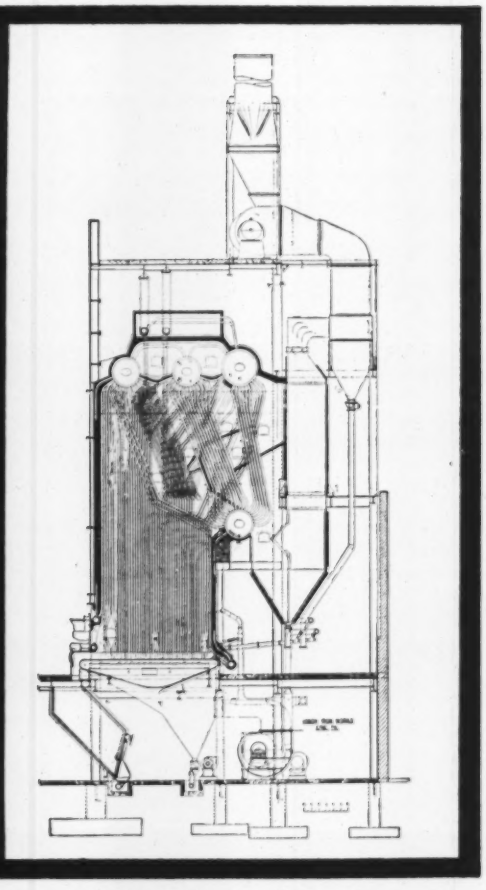



John Strange Paper Co., Menasha, Wisconsin



Longitudinal Section of Union Boiler

# 165,000 lbs/hr Union Boiler plays key role as John Strange wins power modernization award

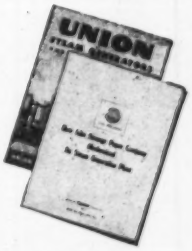
Named 1955 winner of POWER Magazine's Modernization Award, John Strange Paper Company is ranked with the leaders in its industry on the basis of BTU's used per ton of paper produced.

In remodeling its power plant, John Strange followed the recommendations of Cummins and Barnard, Inc. A Union 4-drum boiler was installed to supply steam for both electrical power and processing.

With a steaming capacity of 165,000 lbs/hr at 725 psig and 825° F, this Union semi-outdoor boiler has played a key role in helping boost paper production 10% while saving 29% in fuel costs without increasing plant personnel.

From start to finish, the report "How John Strange Paper Company Modernized Its Steam Generation Plant" is an interesting example of planning power services around a process. It typifies the way in which Union Boilers perform in numerous industrial installations from coast to coast.

**GET FULL DETAILS**
Both a copy of this story, as it originally appeared in POWER, plus illustrated Catalog GB-153 showing several types of boilers built by Union, will be mailed on request. Write.



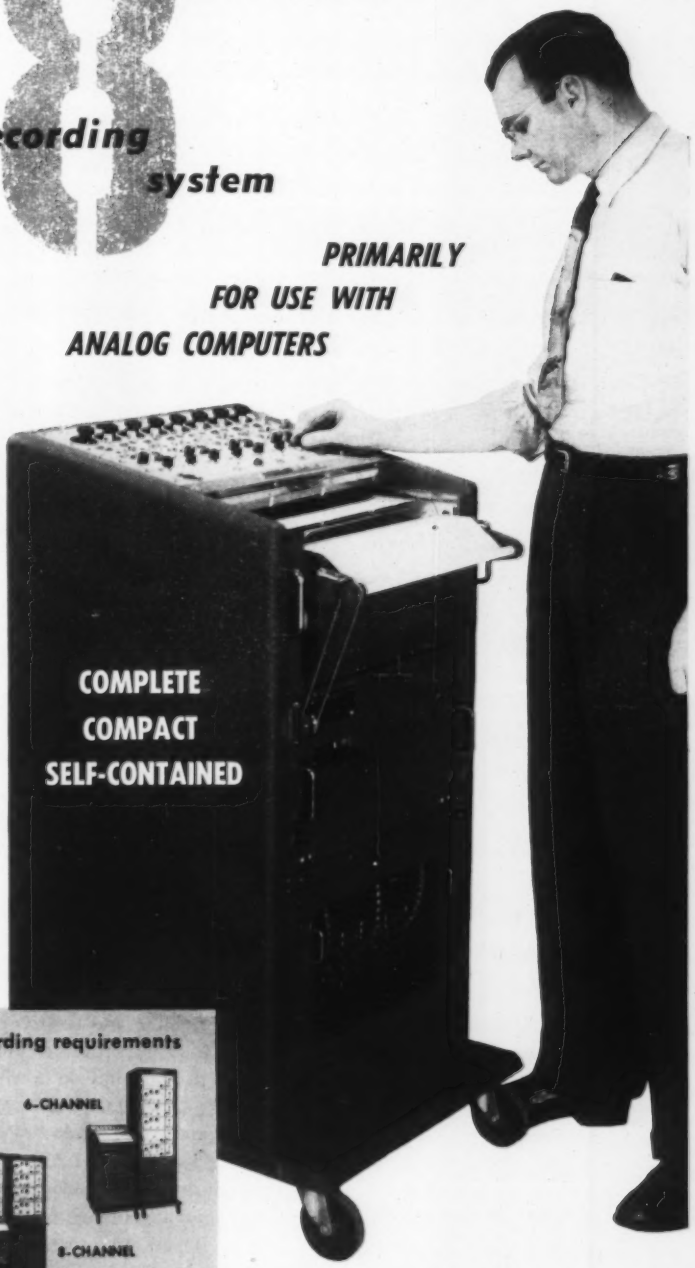

**UNION**

**UNION IRON WORKS**
**ERIE, PENNSYLVANIA**

# NEW 8 CHANNEL

## Sanborn oscillographic recording system

**PRIMARILY FOR USE WITH ANALOG COMPUTERS**




THIS new self-contained 8-channel oscillographic recording system, primarily for (but not limited to) analog computer recording, measures only 46½" x 27" x 22". In a single, space-saving mobile package, the user has a complete system for analog computer readout recording. Input cable connections are easily made at the top of the back panel. Eight groups of controls for the eight channels are conveniently located on the sloping top panel. Driver Amplifier chassis are easily withdrawn from the lower part of the console for inspection. Paper loading is quickly done from the top.

Features of the Model 158-5490 system include 0.1v/cm to 100v/cm sensitivity; over-all linearity of 0.25 mm over the entire 4 cm of the chart; drift less than 0.5 mm/hour; push-pull or single-ended input; miniaturized dual-channel DC amplifiers of improved current feedback design; 5 meg. input impedance each input lead to ground; true rectangular coordinate recording; nine chart speeds from 0.25 to 100 mm/sec. Frequency response is flat to 20 cps, down 2 db at 60 cps for all amplitudes to 4 cm peak to peak.

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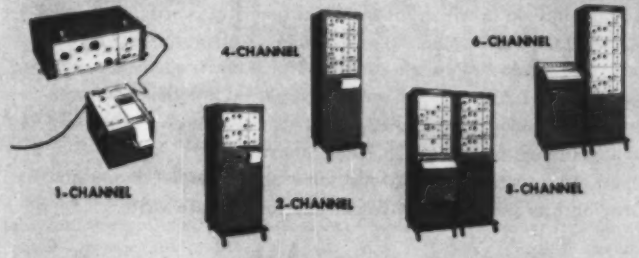


**In laboratories, production testing facilities and field installations nationwide Sanborn 150 Series Oscillographic Recording Systems are proving their versatility and value. Users have a choice of basic systems ranging from 1 to 8 channels . . . "packaged" as portable units or in vertical mobile cabinets . . . and twelve interchangeable plug-in preamplifiers permitting rapid, economical changeover to new input requirements.**

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During the development of the Corporal system, JPL gained a deep appreciation for some of the problems associated with the creation of a completely mobile tactical system. The experience obtained is now being applied in the design of new surface-to-surface weapon systems.

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The Laboratory occupies an 80-acre plot in an otherwise residential area in the San Gabriel mountain foothills North of Pasadena. Its staff of approximately 1,250 persons are all employed by the California Institute of Technology, and it conducts its several projects under continuing contracts with the U.S. Government.

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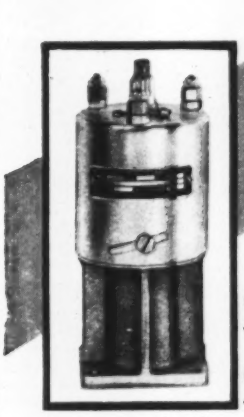

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*For Practical help in solving problems of immediate or long-range importance, consult ASME publications. The following list illustrates the range of subjects covered. For a copy of the complete listing, write to The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.*

ASME TRANSACTIONS FOR 1955
$15.00; $7.50 to ASME members

The experience, ideas, and practical know-how of over 400 specialists are available to you through this 2100-page reference. Specifically it gives quick access to the findings of important researches, information on new materials and their applications, details of product and equipment design, suggestions for improving procedures, and descriptions of new processes. Important problems dealt with in its 224 papers and discussions are those encountered in the fields of applied mechanics, automatic control, fuels, fluid flow, gas turbine power, heat transfer, hydraulics, lubrication, machine design, metal cutting, power plants, and other branches.

PROCEEDINGS, SECOND U. S. NATIONAL CONGRESS OF APPLIED MECHANICS
Pub. 1955
*$9.00 to members and nonmembers

The ninety-five technical papers and four general lectures in this 825-page volume form an invaluable record of recent advances made in connection with many of the significant problems associated with kinematics, dynamics, vibrations, wave motion, mechanical properties of materials and failures, stress analysis, elasticity, plates and shells, plasticity, fluid flow, aerodynamics, and heat transfer.

PROCEEDINGS, EIGHTH INTERNATIONAL CONGRESS ON THEORETICAL AND APPLIED MECHANICS
Published in Turkey, 1956
Distributed in the U. S. by the ASME
*$12.00 to members and nonmembers.

The work of approximately 400 contributors in many parts of the world, this 532-page book makes available a wealth of new knowledge on important problems encountered in the fields of elasticity, plasticity, rheology, fluid mechanics, mechanics of solids, statistical mechanics, thermodynamics, heat transfer, mathematics of physics and mechanics, and methods of computation. Of the 336 papers herein, 214 are in English, 36 in German, 80 in French, and 6 in Italian.

GENERAL DISCUSSION ON HEAT TRANSFER
Pub. 1951
$10.00

The ninety-three contributions and discussions in this 500-page volume cover a decade's development in heat transfer and in the design of apparatus relating thereto and provide a fund of information on heat transfer with change of state; heat transfer between fluids and solids; conduction in solids and fluids; radiation, instrumentation, and measurement techniques; and on a number of special problems.

INDUSTRIAL ENGINEERING TERMINOLOGY
Pub. 1955
$1.50

In this handy 50-page Glossary are listed and defined some 500 terms used by industrial and management engineers. Subjects range from elementary definitions to an entire series of complex production terms. Definitions were formulated by the ASME Work Standardization Committee and have been reviewed and approved by the Terminology Committees of Australia, Canada, South Africa, the United Kingdom, and the ASA.

THE GOLDEN BOOK OF MANAGEMENT
Published in England, 1956
Obtainable in the U. S. from the ASME
*$6.50 to members and nonmembers

This is a historical record of the life and work of seventy individuals from eleven countries who have made original and outstanding contributions to management knowledge. Concerning each person selected the book gives: his portrait or photograph, the reasons for his inclusion, the main facts of his career, a note on his personal characteristics, and the titles of his most important written works on the subject of management. The book does not contain the name of any person still living.

STRUCTURES FOR THERMAL FLIGHT
Pub. 1956
$3.00

Materials at elevated temperatures, optimum airframe structures, factor of safety concepts, and elevated temperature testing techniques are the areas herein covered. The contributions discussing these problems were presented at the 1956 ASME Aviation Conference Division.

CONTENTS: Challenge of Progress. High Speeds Problems of Large Airplanes. Aluminum Alloys for Elevated Temperature Service. Application of a New Structural Index to Compare Titanium Alloys with other Materials in Airframe Structures. Optimum Stresses of Structural Elements at Elevated Temperatures. Thermostructural Efficiencies of Compression Elements and Materials. Weight Efficiency Analysis of Thin Wing Construction. Design Criteria for Heated Aircraft Structures. Discussion on Safety Factor Requirements for Supersonic Aircraft Structures. Some Structural Penalties Associated with Thermal Flight. Aircraft Structural Testing Techniques at Elevated Temperatures. Some NACA Research on the Effect of Transient Heating on Aircraft Structures. Utilization of Solar Furnaces in High Temperature Research.

SHOCK AND VIBRATION INSTRUMENTATION
Published 1956
$5.00

Here will be found engineering data not heretofore published, reviews of previously published information, and descriptions of recent advances and new concepts in the techniques of shock and vibration. Subjects covered include: evaluation of mounts isolating nonrigid machines from nonrigid foundations, experimental studies of the effect of foundation resilience on vibration isolation, effect of material and slip damping on resonance behavior, shock and vibration environments, mechanical design for random vibration and shock, influence of electrical and motional impedance on the control and performance of vibration machines, shock testing machines and procedures, damaging potential of shock and vibration, high speed computing methods for shock and vibration problems.

Throughout the book emphasis is placed on applicable basic principles rather than on explicit problems of only passing interests. The contributions were presented at the 1956 Conference of the ASME Applied Mechanics Division.

VISCOSITY OF LUBRICANTS UNDER PRESSURE
Pub. 1954
$5.00

This publication reviews and co-ordinates twelve experimental investigations on 148 lubricants comprising twenty-five fatty oils, ninety-four petroleum oils, seventeen compounded oils, and twelve other lubricants. Data are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. Conclusions and recommendations are also presented.

MANUAL ON CUTTING OF METALS
Pub. 1952
$10.00

Look to this book for information on the mechanical characteristics and structures of the metals to be cut; on the influence of the composition and microstructures of each metal on the wear of the cutting tool and surface finish; on the types and functions of cutting fluids; on the forces, power, and cutting speeds for specific cuttings speeds conditions when turning a variety of metals; for illustrations of tool shapes which have proved most efficient; and for tabular data on the feeds, speeds, and depths of cut to be used when machining steels and cast irons.

ASME SCREW THREAD MANUAL
Pub. 1952
$2.50

This Manual supplies essential information on threads up to 1½" nominal diameter such as the limits of size of the coarse, fine, and 8-pitch series of Classes 2A and 2B; their gage limits; basic dimensions; tolerances and allowances for standard threads; and formulas for all major, pitch, and minor diameters for the six unified classes of threads. In short, all the specific information a shopman needs about screw threads in general use.

PROPERTIES OF STEAM AT HIGH PRESSURES
Pub. 1956
$1.00

This is an interim steam table in the region of 5500–10,000 psia and 32–1600 F. The sole purpose of its publication is to provide a reasonable extrapolation of the current tables that will be useful in power-systems calculations until an authoritative steam table has been published—five years hence. Its authors have elected to make it consistent in level and join smoothly with the Keenan and Keyes (4) tables along the 5500 psia line.

SCHEME FOR THE IDENTIFICATION OF PIPING SYSTEMS
A13.1—1956
$1.00

This revision emphasizes the importance of identifying the contents of pipes by means of letter legends and presents a systematic plan for accomplishing it. Colors to be used for identifying fire protection equipment, dangerous materials, and safe materials are recommended and illustrations presented of legend placement-width of color bands, as well as size of letters for various diameter pipes.

This scheme concerns only the identification of piping systems in industrial and power plants such as conduits for transport of gases, liquids, semi-liquids or plastics (not solids carried in air and gas), fittings, valves and pipe coverings.

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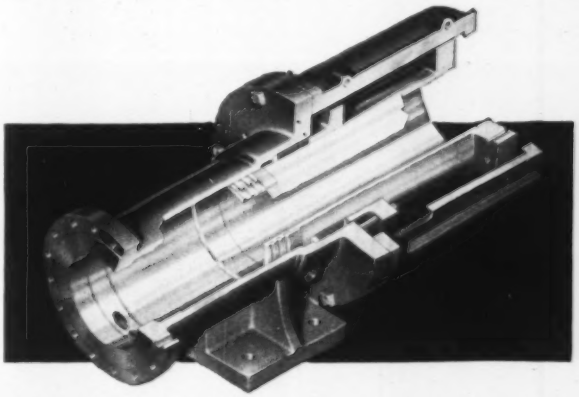

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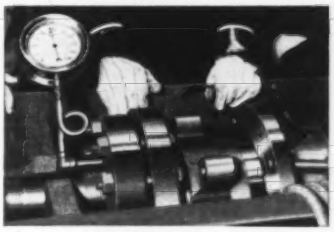

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MECHANICAL ENGINEERING

June, 1956 CARD INDEX Vol 78, No. 6

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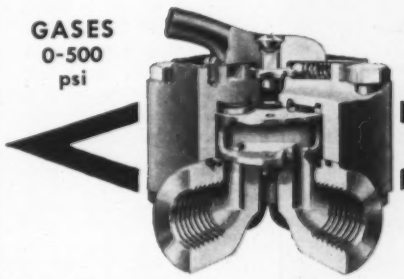

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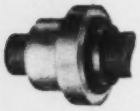

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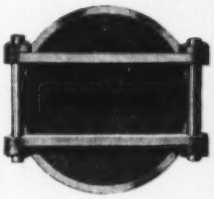

**Write today for Bulletin 523 which describes the Lenape-Lacy Quick Opening Manway in detail.**

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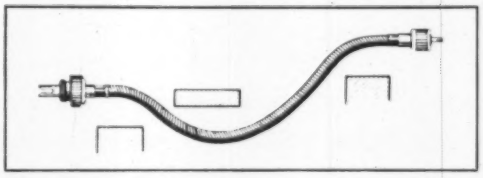
## STRENGTH AND FLEXIBILITY



Recent advances in manufacturing techniques have made possible the production of flexible shafts able to handle loads greatly exceeding those of some years ago when flexible shafting was largely confined to the handling of small loads. This was due to the size of the flexible cable having to be enlarged excessively in ratio to the load applied.

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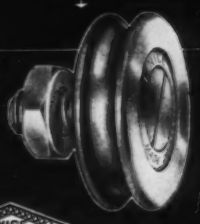

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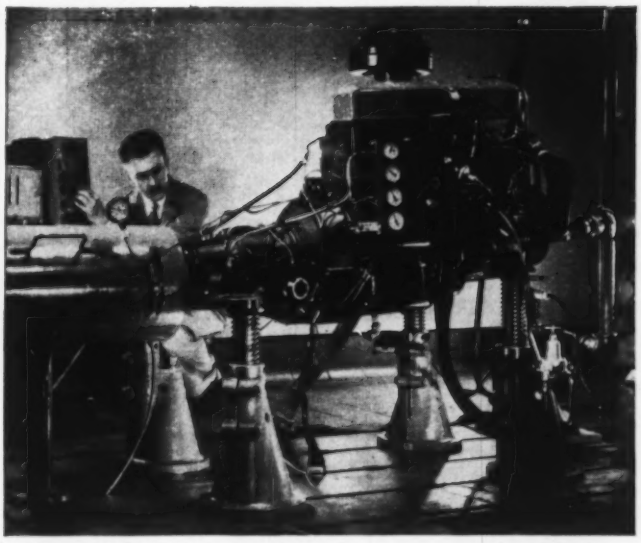

In this dynamometer test, an automobile engine is supported by Lake Shore engine jacks. These versatile jacks have a 360 degree eccentric swing and are quickly adjustable and locked in position. With these engine jacks bolted to a precision-made Lake Shore dynamometer base, you get greater mounting flexibility and more accurate testing control.

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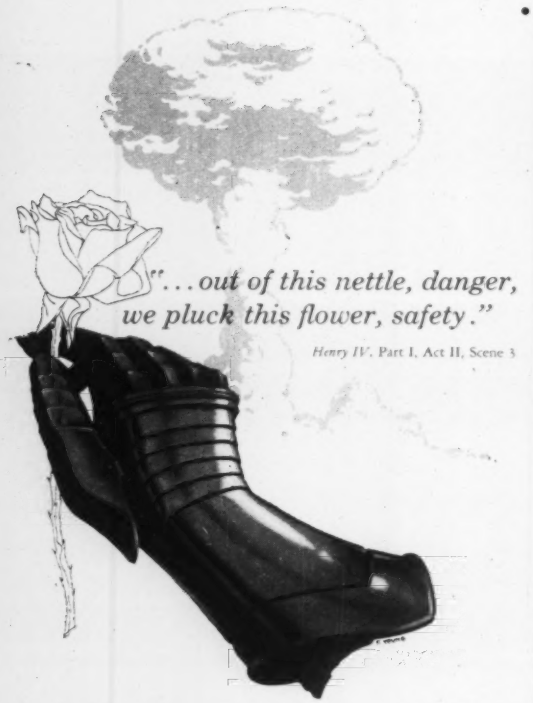


Free people have always lived with danger. For freedom is a precious thing . . . hard won, hard kept . . . under constant threat born of envy.

And yet this very danger is a source of freedom's strength. Time and again, free people have boldly faced dangers that threatened to destroy them, and in so doing found the strength to survive.

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**GEAR TOLERANCES AND INSPECTION, B6.6—1946.** 80¢

Applies to spur, helical, bevel, and hypoid gears. The diameters considered are from ¾ to 100 inches. The pitches range from 1 to 32 diametral pitch. Allowances and tolerances for backlash are also treated.

**20-DEGREE INVOLUTE FINE-PITCH SYSTEM FOR SPUR AND HELICAL GEARS, B6.7—1956.** $1.50

Presents tooth proportions, dimensions of gears and enlarged pinions, tolerances on outside diameter of gears, design data for spur and helical pinions having 9, 8, and 7 teeth, formulas for calculating the values of the various tables, and terminology. To this revision has been added a format for the specification of spur and helical gears.

**FINE-PITCH STRAIGHT BEVEL GEARS, B6.8—1950.** $1.00

Covering generated straight bevel gears of 20 diametral pitch and finer, this Standard gives the gear dimensions, the tooth proportions for 1-diameter pitch, general specifications, dimensions and tolerances for gear blanks, nomenclature, and symbols.

**DESIGN FOR FINE-PITCH WORM GEARING, B.6.9—1956.** $1.50

A design procedure for worms and worm gears with axes at right angles, this Standard gives the proportions of worms and worm gears, values of diameter for all possible combinations of leads and lead angles within the Standard, tooth proportions based on normal pitch for all combinations of standard axial pitches and lead angles, and an extensive table of profile deviations and pressure angle changes. An Appendix added to this 1956 revision explains and illustrates profile deviation in worm threads.

**INSPECTION OF FINE-PITCH GEARS, B6.11—1956.** $2.50

Outlines methods for determining gear quality; recommends the tolerances for gears; and various gear blank elements; specifies the backlash in gears; gives recommendations for machining gear blanks, the pin measurements for spur gears, and procedures for making comparator layouts to check gear and worm profiles; includes directions for using master jaws; classifications for various degrees of surface roughness, waviness and lay; and a list of symbols for use on drawings. A new table in this revision gives the settings for a variable center distance gage for the diverse combinations of total composite errors and tooth thickness reduction.

**A SYSTEM FOR FINE-PITCH BEVEL GEARS, B6.13—1955.** $1.00

Describes the general basis of the system and shows the calculations used to obtain tooth proportions and dimensions of blanks for generated straight bevel gears.

**LETTER SYMBOLS FOR GEAR ENGINEERING, B6.5—1954.** $1.00

**GEAR NOMENCLATURE, B6.10—1954.** $1.50

Provides a system of terms and definitions with illustrative figures applicable to investigations and discussions of gear problems grouped under the following classifications: General designations, kinds of gears, pitch surfaces, boundary surfaces, principal planes, principal directions, elements of gear teeth, linear and circular dimensions, angular dimensions, numbers and ratios, and a miscellaneous group.

**NOMENCLATURE FOR GEAR TOOTH WEAR AND FAILURE, B6.12—1954.** $1.50

Lists, defines, and illustrates the terms for the more common types of wear and failure of teeth of metallic gears.

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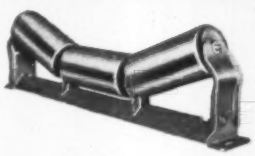

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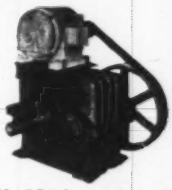

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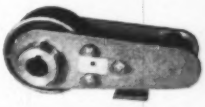

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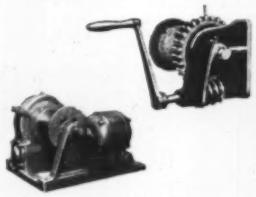

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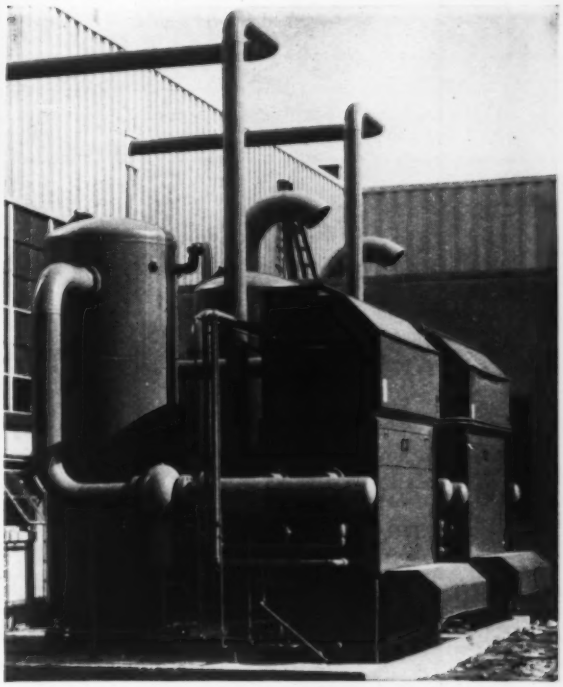

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engineers

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To initiate and direct the design, testing and customer liaison associated with valve and piping developments for atomic power and other nuclear activities. Advancement prospects excellent with company highly regarded for product and research work in power and process fields. Salary open, replies confidential. Write or contact Personnel Director.

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*Preferably with experience in military and electronic equipment.*

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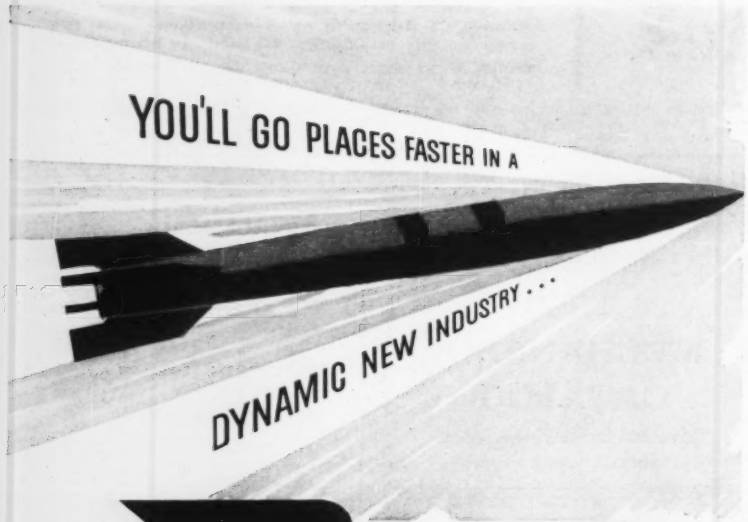


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**Positions are open** at all levels for engineers in fields of: Aerodynamics – Design – Electronics, with emphasis on systems and antenna design – Flight Test Engineering, particularly in instrumentation – Math. Analysis – Operations Research – Structures – Thermodynamics – Weight.

Space prevents us from listing all the reasons we believe you will find significant. There are many others. But if our brief remarks make sense to you, write us and we can explore your opportunities at Lockheed through personal interview or phone. The brief resumé below is simply for your convenience in contacting us.

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I know from my own experience all of the details involved in making a decision about changing jobs. You wonder what kind of work you will be doing...the calibre ... you will be associated with... ing conditions,..is ... is there an ... a short no ... few of the reasons you should get in the mail so that an interview can be arranged.

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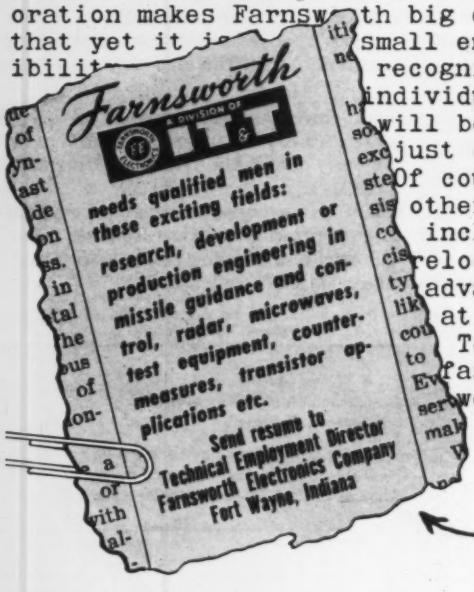
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## IS HERE...

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avco

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Usual benefits in unusual degree. Living and educational advantages in a suburban vacationland.

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You're on a team that unites for the first time both chemical and mechanical experience in research, development, and production of supersonic rockets, ramjets, and liquid and solid propellants.

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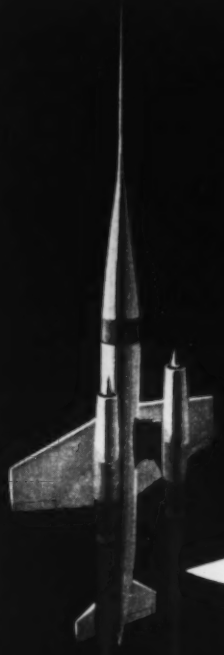
# NDIVIDUAL ROFESSIONAL EVELOPMENT

*for engineers in supersonic propulsion*



Marquardt, the leader in supersonic propulsion, has inaugurated a program of **Individual Professional Development** for its engineers. You can help us maintain this leadership for the future of supersonic propulsion.

**I.P.D.** gives our engineers a chance to advance to their maximum potential in their present fields... and those beyond... in a climate of continuing professional growth from in-plant courses and more than fifty current courses in Southern California's leading universities. New courses are constantly being added.

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Moving soon into new quarters. Work with a group of creative men of similar background. Liberal salary program and complete employee benefit plans.

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**National Carbon Company**
**A Division of Union Carbide and Carbon Corporation**
**P. O. Box 6056, Cleveland 1, Ohio**

## ENGINEER

**HIGH TEMPERATURE METALLURGY AND CORROSION RESEARCH ON NUCLEAR FLIGHT PROJECT**

This senior research position in the application of nuclear energy to the field of flight calls for both versatility and breadth of creative thinking. Every bit of the talent that the qualified engineer brings to this position will be effectively employed in research designed to provide improved metals and alloys for use in an aircraft nuclear power plant.

The job requires a degree in physical metallurgy or metallurgical engineering and 8 to 10 years' experience in working with high temperature or corrosion resistant metals and alloys. (If directly related, time spent on obtaining an advanced degree may be considered part of the experience.)

Publication of research results in the appropriate classified or open literature is encouraged.

**OPENINGS IN CINCINNATI, OHIO AND IDAHO FALLS, IDAHO**

*Address replies, stating salary requirements, to location you prefer*

**W. J. Kelly**
**P. O. Box 132**
**Cincinnati, O.**

**L. A. Munther**
**P. O. Box 535**
**Idaho Falls, Idaho**

**GENERAL ELECTRIC**

**MECHANICAL ENGINEERS**
**A Career With . . .** *Linde*

## IN LIQUID NITROGEN

Unusual and challenging career openings are offered in liquid nitrogen APPLICATION DEVELOPMENT

- **indefinite preservation and processing of biological materials.**
- **design of liquid nitrogen vacuum insulated containers.**
- **application of extreme pressures and low temperature.**
- **application of liquid nitrogen temperature in the shipment of frozen foods without intransit refrigeration.**

The magnitude and diversity of LINDE products and processes are appealing to Mechanical Engineers who are seeking employment with a dynamic company of proven stability

Bachelors or Masters are invited to investigate

**LINDE AIR PRODUCTS COMPANY**
**a division of**
**UNION CARBIDE AND CARBON CORPORATION**
**Send resume to: Mr. P. I. Emch**
**P. O. Box 44, Tonawanda, New York**
**Refer to ad: ME-N**

## CHIEF PUMP ENGINEER

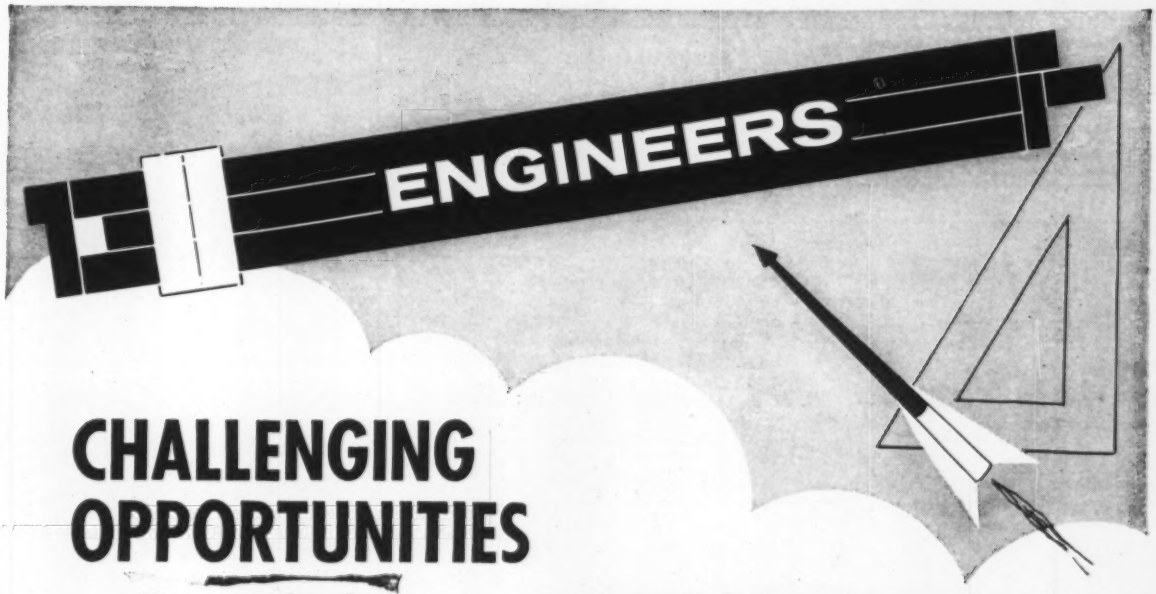
Leading pump manufacturer, located in large Midwest city, needs Chief Pump Engineer, age 35–55. Must have ten years of specific experience in the design of single and double suction clear water pumps and non-clogging pumps for liquids containing solids and five years of responsible charge of design and pump engineering department. Will report to Works Manager. Write in confidence.

Address CA-5745, % "Mechanical Engineering."

## OXYGEN ENGINEER

To design and develop aircraft Oxygen breathing systems for passenger and crew use. Exceptional opportunity for creative research in tremendously expanding field with long established midwestern corporation. Age 30–45, family man preferred. Salary open—based on your qualifications. Will pay interview expenses. Give complete education, position held, availability, and salary desired. Replies definitely confidential.

Address CA-5775, % "Mechanical Engineering."




# CHALLENGING OPPORTUNITIES

**IN**
- **Avionics**
- **Computers**
- **Jet Engine Fuel Controls**
- **Inertial Systems**
- **Missile Guidance**

***WITH AC THE ELECTRONICS DIVISION OF***

## General Motors

ALL GRADUATE ENGINEERS are offered permanent job opportunities. We extend a cordial invitation to every deserving Engineer and Designer to write us their wants. We may be able to supply the square hole for the square peg!

YOUR FUTURE depends on your making the right connection with the right firm as quickly as possible.

The men hired will enjoy working with some of the top men in the field and with the finest test, research and development facilities. GM's long-standing policy of decentralization creates individual opportunity and recognition.

Why not send us full facts about your education, work background, etc. We will do all we can to treat your application with the fullest confidence.

AC SPARK PLUG — THE ELECTRONICS DIVISION
**GENERAL MOTORS CORPORATION**
MILWAUKEE 2, WIS. — FLINT 2, MICH.

### CHIEF MECHANICAL ENGINEER

Graduate Engineer to supervise design and preparation of drawings for heating, ventilating, air conditioning and piping systems, for hydroelectric plants. Nationally known Consulting Engineer Office. Opportunity to grow with organization and participate in profits. Send complete resume of education and work history; also statement of acceptable salary range and approximate availability. Confidence will not be violated.

Address CA-5751, care of "Mechanical Engineering."

### MECHANICAL ENGINEER-POWER

Recent graduate, veteran, to understudy plant engineer, national chemical company. Indianapolis location. Salary $450–550 month start. Write age, education and experience.

Address CA-5744, % "Mechanical Engineering."

### DESIGN ENGINEER

Excellent opportunity for a really creative engineer willing to grow into administrative responsibilities. Inventiveness and the ability to be truly objective are the keys to a successful career with a progressive organization having the largest Research and Engineering facilities in the steel valve industry.

**Edward Valves, Inc., Sub. of Rockwell Mfg. Co.**
**East Chicago, Indiana**

## MECHANICAL ENGINEERS

Interesting positions available for persons qualified to perform research in the fields of theoretical or experimental stress analysis, and dynamics.

Applicants should have an M.S. degree or equivalent and should have considerable training in dynamics, elasticity and mathematics.

These positions offer careers in challenging work where high emphasis is placed on creative ability. We offer excellent employee benefits including tuition-free graduate study. Please send resume to:

**Mr. J. A. Metzger**

**ARMOUR RESEARCH FOUNDATION**
**of**
**Illinois Institute of Technology**
**10 West 35th Street**
**Chicago 16, Illinois**

## EXPERIMENT INCORPORATED

Located in Virginia, EI is one of the nation's leading independent research and development organizations.

## MECHANICAL ENGINEERS

who are young and imaginative are needed to work on many interesting projects. For details on typical projects and the complete EI story, write for our descriptive brochure. Address inquiries and resumes to Personnel Manager.

**EXPERIMENT INCORPORATED**
**Richmond 2, Virginia**

### MECHANICAL AND METALLURGICAL ENGINEERS

**Take Advantage of Unusual Opportunites With . . . .**
**in FLAME PLATING**

*Linde*

This unique and revolutionary process for applying thin coatings of tungsten carbide and other materials to metals is undergoing extensive development at our new, air-conditioned Speedway Laboratories in suburban Indianapolis. Challenging and rewarding career openings are offered to engineers interested in:

- **controlled detonations**
- **process engineering**
- **instrumentation and controls**
- **equipment design**
- **acoustic engineering**
- **corrosion**
- **wear**
- **surface finishing**

B.S., M.S., or Ph.D. graduates with up to 5 years' experience and demonstrated technical ability are needed for:

- **DEVELOPMENT**
- **RESEARCH**
- **PRODUCTION**
- **SALES**

Send complete resume including education (approximate academic achievement), experience and work interest to:

**LINDE AIR PRODUCTS COMPANY**
**a division of**
**UNION CARBIDE AND CARBON CORPORATION**
**P. O. Box 8237, Indianapolis 24, Indiana**
**Attention: Mr. J. J. Rostosky**
**Refer to ad: ME-YP**

## WANTED ASSISTANT CHIEF ENGINEER

Graduate Mechanical Engineer, or equivalent, with a minimum of three years' experience in high pressure power plant operation. A high caliber man is required in the operation and maintenance of 1250-pound pressure, pulverized fuel fired, steam-electric power plant located in the midwest.

Write stating education, experience, salary expected, and availability. All replies will be held confidential.

Address CA-5687, % "Mechanical Engineering."

## ENGINEER

**Immediate opening in Petro-Chemical field for recent graduate to select pump and compressor equipment. Involves liaison between customers and manufacturer's engineers.**

**Excellent opportunity for professional growth in engineering and administration. Location N.Y.C. Many employee benefits. Send resume including salary requirements to:**

**Address CA-5791, care of "Mechanical Engineering."**

## Mechanical Engineer

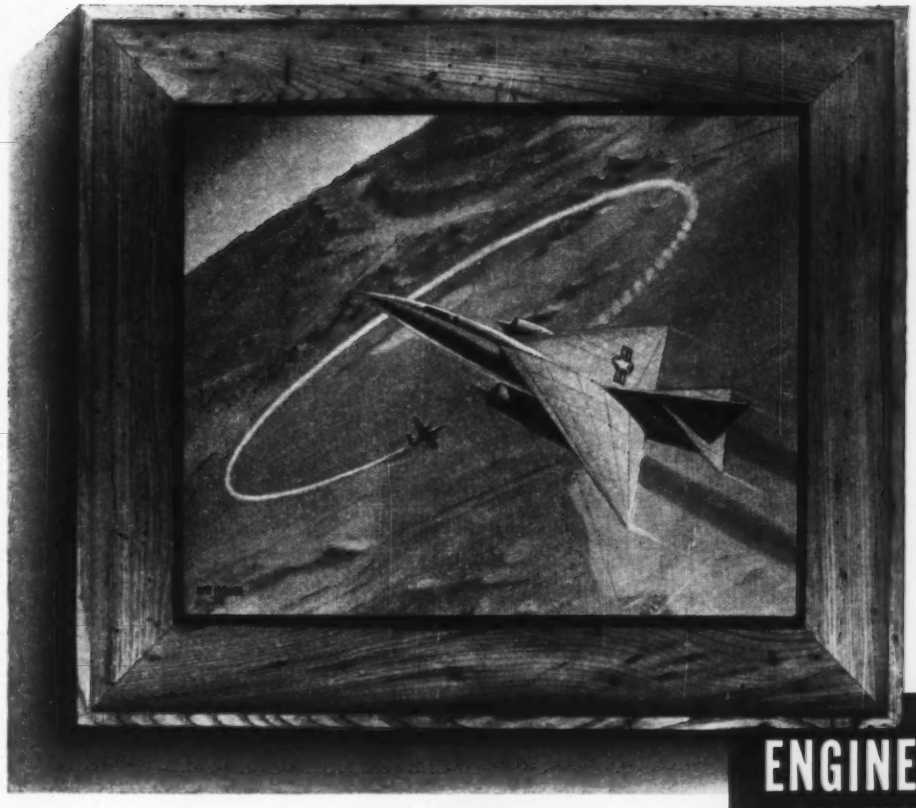
Design air conditioning, heating and ventilating, plumbing, pipefitting, gas fitting for new and existing facilities. Work is on campus of one of the leading scientific institutions of the West.

Good benefits. Moving expenses paid.

*Write for additional information or send resume to:*

Mr. J. N. Ewart
*Personnel Director*

**California Institute of Technology**
PASADENA, CALIFORNIA



# *The art of rocketry*

The portraits of tomorrow's propulsion systems are rapidly becoming realities at Aerojet-General. America's foremost manufacturer of rocket powerplants, Aerojet is a major contributor to this nation's most critical rocket and missile programs.

***But creation takes talent.***

Operations at Aerojet's California plants, near Los Angeles and Sacramento, are expanding rapidly. Unparalleled career opportunities exist for scientific and engineering personnel at all levels of experience.

Please write the Director of Personnel, Aerojet-General Corp., *Box 296BB, Azusa, Calif.*, or *Box 1947BB, Sacramento, Calif.*

Your resume will receive immediate, confidential attention.

**ENGINEERS**
**ALL FIELDS**

**CHEMISTS**

**PHYSICISTS**

**MATHEMATICIANS**

**METALLURGISTS**

**DRAFTSMEN**

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A Subsidiary of The General Tire & Rubber Company

THE GENERAL TIRE

AZUSA, CALIFORNIA
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MORE POWER FOR AIR POWER

# ENGINEERS:

*Mechanical & Electromechanical*

## If you can do original work

. . . you should consider The Johns Hopkins University Applied Physics Laboratory (APL), where creative ideas are recognized and supported.

The Laboratory is primarily concerned with research and development of guided missile systems. A sizeable program of fundamental research is concurrently in progress.

APL is responsible for technical direction of the Navy's Bumblebee guided missile program. Developments at APL include the first supersonic ramjet, and the missiles TERRIER, TALOS and TARTAR.

A distinguishing feature of the Laboratory is the self-dependence of the professional staff members, who work in an atmosphere of free inquiry and are unhampered by the usual administrative details. Problems are attacked by teams, each of which maintains a fine balance between research and engineering. The team approach allows each member to acquire broad knowledge, find his creativity heightened.

The location of the Laboratories in the Washington D.C.-Baltimore periphery places staff members near fine housing in all price ranges, recreational and cultural facilities. Moving expenses paid in full. Liberal educational benefits for study at a number of excellent universities nearby.

**OPENINGS EXIST IN:**

**DESIGN: airframes and structures; hydraulic and power supply systems; servomechanisms, launching and handling equipment, ramjet engines.**

**ANALYS'S: stress, weights and loads, heat transfer.**

*For additional information write: Professional Staff Appointments*

**The Johns Hopkins University Applied Physics Laboratory**

**8607 Georgia Avenue, Silver Spring, Md.**

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## EXTRUSION, DESIGN ENGINEERS

**RESEARCH AND DEVELOPMENT ORGANIZATION**

**Our growing solid propellant and rocket development program and industrial projects have openings for several well-qualified mechanical engineers:**

1. **With demonstrated ability in mechanical design, pressure vessels, and/or stress analysis, and B.S. to Ph.D. in mechanical engineering, 2 to 10 years' suitable experience.**
2. **For pilot plant and semi-production extrusion development work; familiar with materials, techniques, and die design. B.S. or M.S. in mechanical or chemical engineering desirable.**

**Technically demanding assignments that will be especially interesting for persons with capabilities for professional growth.**

**Send detailed resume of experience, education, salary requirements, and professional references.**

**ATLANTIC RESEARCH CORPORATION**

**ALEXANDRIA VIRGINIA**

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## MECHANICAL ENGINEERS

**Junior to Senior Levels**

**Work on heat transfer problems, design electronic equipment, gear trains, chassis layout to government specifications. Some knowledge of servo-mechanisms desirable.**

**You are needed, well-appreciated, and well-rewarded . . .**

**In GOOD PAY**
**In INTERESTING WORK**
**In LONG-TERM PROGRAMS**
**that will increase your career potential at . . .**

**RADIO RECEPTOR Co.**

*• Send resume to: S. Winston • or call EVergreen 8-6000*

**240 WYTHE AVE., BROOKLYN, N. Y.**

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## STAFF ENGINEERS for new RESEARCH & DEVELOPMENT DEPARTMENT

**advanced electric systems and accessories for aircraft and missiles**

### Mechanicals with MS

Ten years' experience mechanical problems of aircraft accessories or equivalent in allied field. Working knowledge of modern experimental techniques essential.

### Thermal Specialists with PhD

Five years' experience heat transfer to gases and liquids. Mastery advanced mathematical and experimental techniques.

### Many Benefits

R&D Department in suburban Cleveland, O., plant. Fine, new offices and complete, modern laboratory, computing and prototype production facilities.
Many extra company-sponsored benefits conducive to creative engineering.
Superb family environments and activities.

Send resume.
Address CA-5788 care of "Mechanical Engineering."

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## MECHANICAL ENGINEER

Graduate mechanical engineer interested in power plant design work. Experience not required. Excellent opportunity with consulting engineering firm in the Middle West. Liberal benefit plans and good working conditions.

Send resume of education and experience with statement of salary requirements.

Address CA-5721, % "Mechanical Engineering."

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## SALES AND SERVICE ENGINEERS WANTED

Excellent opportunities for engineers with well established East Coast Industrial Instrument Manufacturer now expanding branch office coverage.

Electrical, Mechanical, or Electronic Engineers preferred.

Openings for Sales Engineers in St. Louis, Los Angeles, Cleveland, and Boston.

Openings for Service Engineers in Buffalo, Los Angeles, and San Francisco.

Generous company paid benefits include hospitalization, pension, insurance, and vacation plans.

Address CA-5746, % "Mechanical Engineering."

---

## SENIOR ENGINEER

Experienced in design and construction of high pressure equipment, such as Pumps, Compressors, Vessels, Pilot Plants, etc. Estimating experience desirable but not necessary. Salary open. Give full particulars in first reply.

**AMERICAN INSTRUMENT CO.**
**8030 GEORGIA AVE.**
**SILVER SPRING, MD.**
***IN METROPOLITAN WASHINGTON, D. C.***

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## MECHANICAL ENGINEER

**Experienced in hydraulic design of Centrifugal Pumps.**

Work will involve research and development of centrifugal and axial flow pumps of all types, with fine opportunity for advancement.

A liberal benefit program.

Starting Salary commensurate with ability.

Send letter and resume to:—

**R. E. Ostermick**
**Employment Department**
**ALLIS-CHALMERS MANUFACTURING COMPANY**
**Box 512, Milwaukee 1, Wisconsin**

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**Use a CLASSIFIED ADVERTISEMENT**
***For QUICK RESULTS***

# MECHANICAL ENGINEERS:

## A Career at Electric Boat... Is An ADVENTURE in Engineering

In the past several years, Electric Boat has been making one headline after another as the nation's first adaptor of nuclear power for propulsion. The Electric Boat-designed and built atom submarines, Nautilus and Seawolf, are already accomplished fact.

Behind the headlines, the work of designing even more advanced atomic submarines goes on. Every day, Electric Boat engineers are coming to grips with problems in nucleonics that pave the way for applications in other fields.

There is room — and opportunity — for more engineers able to cope with these problems. Current openings are for Mechanical Engineers with experience in vibration and shock, machine design, stress analysis, hydraulics, rotating machinery, power plants, or air-conditioning and piping.

These jobs offer more than engineering adventure. There's common-sense practicality involved, too. Electric Boat's backlog of orders and years-ahead plans; its record stable engineering employment; its sponsorship of advanced study at leading universities and within the plant are some of the practical features. New England living on the shores of Long Island Sound is another.

To find out more details about these opportunities, write us details of your background and experience including initial salary requirements. Interviews will be arranged promptly for qualified applicants. Please address **Peter Carpenter.**

**ELECTRIC BOAT**

**DIVISION OF GENERAL DYNAMICS CORPORATION**

GROTON, CONNECTICUT

# Engineer, Design

## ADVANCED DESIGN GROUP AIRCRAFT NUCLEAR PROPULSION PROJECT

At General Electric's ANP Department esprit de corps is part of the work-environment. This is because the application of nuclear power for aircraft propulsion offers the qualified engineer the opportunities for personal achievement that go with professional challenge.

A responsible position is now open for an engineer interested in this field; must have an engineering degree, several years' diversified experience in analysis and design of power plant components, including design of nuclear reactors. The job carries the responsibility for preliminary design analysis of power plants, and directing completed scale design and layout drawings of power plants and equipment.

Publication of research results in the appropriate classified or open literature is encouraged.

**OPENINGS IN CINCINNATI, OHIO AND IDAHO FALLS, IDAHO**

*Address replies stating salary requirements to location you prefer*

**W. J. Kelly**
**P. O. Box 132**
**Cincinnati, O.**

**L. A. Munther**
**P. O. Box 535**
**Idado Falls, Idaho**

**GENERAL ELECTRIC**

# QUALITY CONTROL ENGINEER

Degree in ME, EE, or Mathematics. Industrial experience desired, familiarity with statistical quality control techniques essential. Please send complete resumé to:

*Staff Employment Division 5538*

**SANDIA CORPORATION**

**Albuquerque, New Mexico**

## TECHNICAL SALES

Graduate engineers for technical sales or technical service with two or more years' experience—not necessarily in sales. Training in our polyethylene plastics laboratory with commercial size processing equipment. Field work with firms engaged in the molding and extrusion of polyethylene.

This is an exciting, fast growing field, where excellent opportunities exist for future advancement. Please write giving complete resume of education, experience and salary requirements to:

**Spencer Chemical Company**
**500 Dwight Bldg.**
**Kansas City, Mo.**
**Attn: Personnel Manager**

## MECHANICAL ENGINEERS

**Realize your Maximum Potential With...** *Linde*

**IN**

## ACETYLENE ENGINEERING AND DEVELOPMENT

The expanding acetylene program at our new, air conditioned Speedway Laboratories located in suburban Indianapolis offers unusual and challenging career openings involving:

- **heat transfer**
- **fluid flow**
- **catalysis**
- **gas kinetics**
- **thermodynamics**
- **pressure vessel design**

Engineers interested in the above fields and capable of assuming responsibility for new projects are needed for:

- DEVELOPMENT of novel methods of acetylene production and distribution
- DESIGN of new plants and equipment for supplying chemical acetylene in pipeline quantities
- ENGINEERING for our production and distribution systems
- TECHNICAL SERVICE for Linde's nationwide acetylene business.

B.S., M.S., or Ph.D. graduates submit resume covering education (include approximate academic achievement), experience and work interests to:

**LINDE AIR PRODUCTS COMPANY**

**a division of**
**UNION CARBIDE AND CARBON CORPORATION**
**P. O. Box 8237, Indianapolis 24, Indiana**
**Attention: Mr. J. J. Rostosky**
**Refer to ad: ME-A**

# "OPPORTUNITIES" . . . . 123-139

## MECHANICAL RESEARCH ENGINEERS

Expanding industrial research programs have resulted in opportunities for engineers experienced or interested in any of the following fields:

Applied Mechanics
Fluid Mechanics
Reactor Engineering
Internal Combustion
Aerodynamics
Heat Transfer
New Product Design

These positions offer out-of-the ordinary promotional opportunities in a stable, progressive organization which has enjoyed a threefold expansion in the last ten years. For technical application and literature describing our operations, write to

**Technical Personnel Manager**
**BATTELLE MEMORIAL INSTITUTE**
**505 King Avenue**
**Columbus 1, Ohio**

## POWER ENGINEER

With 3–4 years' engineering experience to assist on engineering projects related to operating an industrial plant utility system consisting of 14 boiler—800,000# per hour steam plant, 4 machine—16,000 kw electrical plant and 20,000,000 gallon per day water supply system.

Engineering includes planning, construction, and technical supervision of steam, power, water, gas and compressed air facilities.

Electrical or mechanical engineer with power option preferred. All replies confidential.

Please send details of your qualifications to—

**Personnel Department**
**A. E. STALEY MANUFACTURING COMPANY**
**Decatur, Illinois**

**MECHANICAL ENGINEERS:** Two newly created positions open with small and medium construction equipment manufacturer. Excellent growth picture. Young management is expansion minded. Located in Midwest.

**PRODUCT ENGINEER**—1956 graduate, or applicant with 2–3 years' experience. Duties involve product engineering and some new development work. Starting salary $450–700 month, depending on background and abilities of individual.

**ASST. CHIEF ENGINEER**—Young, ambitious creative individual with demonstrated management and leadership abilities. Should be 26 to 35. Capable of supervising small department. Unique opportunity for high calibre person. Annual starting salary in five figures. Applicants should have history of highly successful progress and should enjoy chance to work with high degree of independence.

All applications will be treated confidentially. Enough material should be forwarded to permit preliminary evaluation of training, experience, interests, and ambitions. Each application will be acknowledged.

Address CA-5756, % "Mechanical Engineering."

*engineers*
***M.E.***

## ORIGINAL THINKERS
*in*
## MECHANICAL DESIGN

These two positions open at General Electric's Naval Ordnance Department will give engineers with five or more years of mechanical design experience a chance to develop, observe and promote new ideas.

One is a rare opportunity to work on advanced projects dealing with structure and stress analysis, utilizing the latest techniques and materials.

In the second position, you will produce sound, advanced mechanical designs, provide technical directions with manufacturing where new techniques are required; plus design contacts and liaison; perform tests on materials; provide assistance to other units.

You will live in the forward-looking city of Pittsfield, Mass. in the heart of the Berkshire vacationland, and work for a forward-looking company, where you get professional recognition along with numerous benefits that make GE known throughout industry as a "good place to work."

**Excellent Salary,**
*commensurate with experience.*

*Please reply in confidence to:*

**Manager, Engineering Admin.**
**Naval Ordnance Department**

**GENERAL ELECTRIC**

**100 Plastics Ave., Pittsfield, Mass.**

## MECHANICAL ENGINEERS

**Research and Development**

Interesting positions open for Mechanical Engineers on a wide variety of projects in the following fields:

**Heat Power Equipment** — **Fluid Mechanics**
**Thermodynamics** — **Heat Transfer**

M.S. to Ph.D. in Mechanical Engineering with three to five years' experience in one of these fields essential. These positions offer an opportunity to use your initiative and creative ability. We offer excellent employee benefits including tuition-free graduate study. Please send complete resume to:

**Mr. J. A. Metzger**
**ARMOUR RESEARCH FOUNDATION**
**of**
**Illinois Institute of Technology**
**10 West 35th Street**
**Chicago 16, Illinois**

*Linde*

## and LOW TEMPERATURE ENGINEERING

**We have unlimited opportunities for MECHANICAL ENGINEERS in:**

- **equipment design**
- **instrumentation and controls**
- **pilot plant design and operation**
- **process engineering**
- **fabricating techniques**
- **heat transfer**
- **fluid flow**
- **thermodynamics**
- **distillation**
- **stress analysis**

These projects are associated with the production and distribution of oxygen, nitrogen and argon as low temperature liquid or gases.

LOCATION: Our Tonawanda Laboratories in suburban Buffalo, New York—our largest research and development facilities.

B.S., M.S., Ph.D. graduates with up to five years' experience are invited to investigate.

**LINDE AIR PRODUCTS COMPANY**
**a Division of**
**UNION CARBIDE AND CARBON CORPORATION**
**Send resumés and approximate academic standing to:**
**Mr. P. I. Emch, P. O. Box 44, Tonawanda, N. Y.**
**Refer to ad: ME-L**

## HYDRAULIC ENGINEER

familiar with hydraulic turbine work, design and application.

ALSO

experienced draftsman on hydraulic turbines Old established company. No age limit. Excellent opportunity with future for the right men.

Address CA-5739, % "Mechanical Engineering.

## AREA ENGINEERS

Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants or related operations. To establish technical supervision, procedures, maintenance operations, and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

*Recruiting Supervisor, Box 66*

**ARABIAN AMERICAN OIL COMPANY**

**505 PARK AVENUE**
**NEW YORK 22, N. Y.**

## MECHANICAL ENGINEERS

Several excellent opportunities available with major producer of synthetic fibers and films. Openings are current in plant engineering departments in Pennsylvania, Virginia, and West Virginia.

Graduate mechanical engineers with 0–5 years of experience in machine and equipment design, mechanical layout, engineering maintenance, or related activities are invited to reply.

Please send resume including details of education, experience, and salary requirements to:

**Personnel Recruitment Department**

**AMERICAN VISCOSE CORPORATION**

**1617 Pennsylvania Boulevard**
**Philadelphia 3, Pennsylvania**

## MECHANICAL ENGINEER

**Design and Development of**

**GAS WELDING AND CUTTING TORCHES**

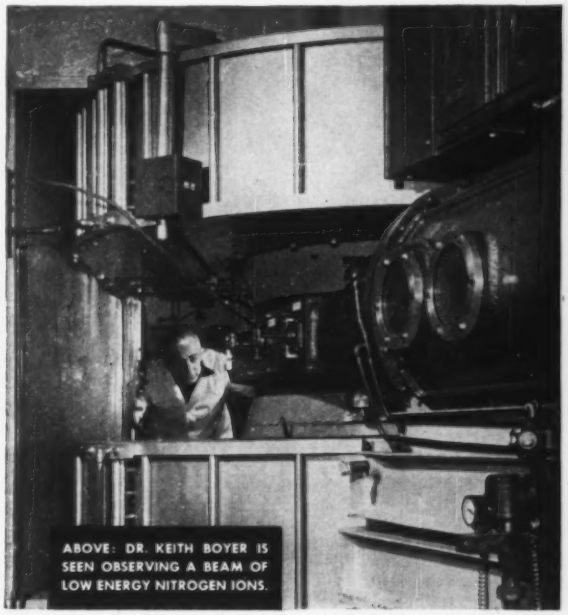
To assist in the design and development of torches and related apparatus with the K-G Welding Equipment Division of the country's leading producer of oxygen generators.

The Senior Engineer must be experienced in the field. The Junior Engineer should have interest in the design and development of small apparatus but prior experience on welding apparatus is not mandatory.

Both positions are high salaried and include profit sharing plus opportunity to progress rapidly into the management of an expanding organization.

**Send resume to**
**B. H. VanDyke, Air Products, Incorporated,**
**P. O. Box 538, Allentown, Pa.**

# BASIC RESEARCH at los alamos



ABOVE: DR. KEITH BOYER IS SEEN OBSERVING A BEAM OF LOW ENERGY NITROGEN IONS.

The cyclotron shown above is one of the many types of advanced research equipment in use at Los Alamos. This variable energy machine is designed to accelerate high intensity beams of all the hydrogen and helium isotopes.

The Laboratory offers a wide range of opportunities to do research and development work in the fields of Physics, Chemistry, Metallurgy, Mathematics, Computing and Engineering.

If you are interested in learning more about career opportunities at Los Alamos, write—

**DEPARTMENT OF SCIENTIFIC PERSONNEL**
**Division 1007**

**los alamos**
**scientific laboratory**
OF THE UNIVERSITY OF CALIFORNIA
**LOS ALAMOS, NEW MEXICO**

# Your ENGINEERING career can begin when you move to MOTOROLA!

Maybe you've been an engineer for 2 or 20 years, but feel you've got just a job, not a career. If you yearn for a larger, more important challenge and all the benefits that go with it—security, good pay, professional respect and accomplishment—you can start carving a career for yourself at Motorola TODAY. Your future is insured at the company with a future . . . so join the move to Motorola. If you are an ELECTRICAL ENGINEER, MECHANICAL ENGINEER, PHYSICIST, PHYSICAL CHEMIST or METALLURGIST (Senior or Junior level) contact Motorola today.

**CHICAGO, ILL.** *Write to: L. B. Wrenn, 4501 Augusta Blvd.*, for challenging positions in Two-Way Communications, Microwave, Radar and Military equipment, Television (Color), Radio Engineering, and Sales Engineering.

**PHOENIX, ARIZ.** *Research Laboratory. Write to: R. Coulter, 3102 N. 56th St.* for outstanding opportunities in the development and production of Military equipment and Transistor products.

**PHOENIX, ARIZ.** *Transistor Laboratory. Write to: V. Sorenson, 5005 E. McDowell Road* for excellent opportunities for Transistor Application Engineers, Physical Chemists, Metallurgists, Physicists and Transistor Device Development Engineers.

**RIVERSIDE, CAL.** *Write to: C. Kozial, 8330 Indiana Ave.* This new modern research laboratory, located 65 miles from Los Angeles, needs men in Missile and Military equipment systems analysis and design.

*write today for personal interview*

**MOTOROLA**

## PROJECT ENGINEER

Wanted by manufacturer of Pulp and Paper Mill machinery for work in Research and Development. Must be a graduate mechanical engineer with a minimum of five years' experience, including at least one year in machinery design, or as an engineer in the Pulp and paper industry — New England location. Give detailed resume of experience.

Address CA-5779, % "Mechanical Engineering"

Wanted by a large and progressive Canadian Corporation a top flight Mechanical Engineer, preferably with experience in the design of stone crushing and processing plants, asphalt plants, concrete plants, cement plants and conveying equipment, etc.

Must be creative and capable of producing finished designs through his own initiative and efforts that can be detailed by staff.

Interested party should forward complete resume of experience and all vital statistics, including salary required.

If applicant does not desire to disclose identity until interviewed and final negotiations are in effect, blind applications or third party submissions will be satisfactory. All information given will be held in confidence.

Address CA-5758, % "Mechanical Engineering."

## REFRIGERATION AND AIR CONDITIONING ENGINEER

**Graduate M.E. with minimum 8 years' broad experience in refrigeration and air conditioning design and project work. To render technical service to operating units and serve as staff consultant on air conditioning and refrigeration problems related to overseas operations located in Saudi Arabia.**

**Facilities include large central air conditioning plant with chilled water distribution system through entire communities for residential and industrial air conditioning totaling 14,000 tons capacity, plus 700 tons of refrigeration for manufacture of ice and storage of commissary supplies.**

***Must be capable of developing and carrying work assignments to completion. For assignment in New York Engineering Office, occasional field trips required.***

**Write outlining work experience and personal history.**

**Recruiting Supervisor, Box 123**

**ARABIAN AMERICAN OIL COMPANY**

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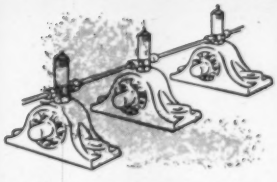

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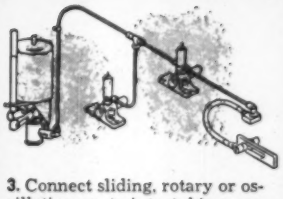

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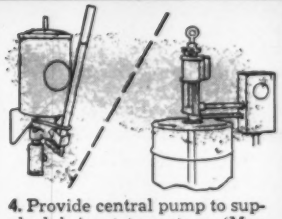

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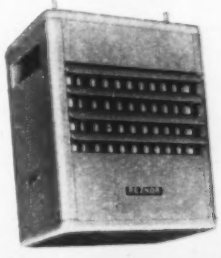
"When the old heating boiler at this plant gave out, we were told it would cost $150,000 to replace it. Then we discovered we could have a Reznor heating system for approximately one-fifth of that cost. It's a big building . . . 165,000 square feet of space to be heated. It took 64 Reznor heaters and over 20,000 feet of pipe to do the job, but we saved $120,000 on equipment and original installation. And we're saving a lot more on operation and maintenance costs. For example, we saved $15,000 a year in salaries by eliminating the four men formerly needed to operate the boiler room. And the plant is more comfortably heated than it ever was before."



**Only Reznor Gas Unit Heating Offers All These Advantages**

- Low Equipment Cost
- Low Installation Costs
- Low Operating Costs
- Instant Response to Every Change in Temperature
- No Maintenance Problems
- Waste No Floor Space
- Extra Heat for Trouble Spots
- Complete Adaptability to Future Construction

*For more information mail the coupon below or call your nearby Reznor distributor. He's listed under "Heaters-Unit" in the yellow pages of your telephone directory.*

**REZNOR**
THE WORLD'S LARGEST-SELLING GAS UNIT **HEATERS**

**REZNOR MANUFACTURING COMPANY**
71 Union Street, Mercer, Pa.

☐ Please send me my free catalog on Reznor gas heating equipment.
☐ Please have a representative call to discuss our plant heating problems.

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# what is grey matter worth?

For the engineer or scientist who has enough to make him different, *grey matter* is worth a rewarding life of creative achievement in a working climate where ideas are King...and the benefits measure up to the man and his mind.

For 56 years Firestone has grown on *grey matter* – in Research, Development and Production. Now, simply, we need additional *grey matter* for such Firestone "firsts" as the "Corporal" surface-to-surface ballistic missile. Here are just a few of the Engineering activities in which Firestone needs more *grey matter:*

*Electronics Systems*
*Mechanical Systems*
*Propulsion Components*
*Flight Simulation*
*Mechanical Structures and Dynamics*
*Stress Analysis*
*Metallurgical Lab*

If you're the man with extra *grey matter* who wants the chance to really use it, write us today. We'll put you in touch with a Firestone man who has your kind of *grey matter*, too.

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WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

# LUNKENHEIMER OPENS

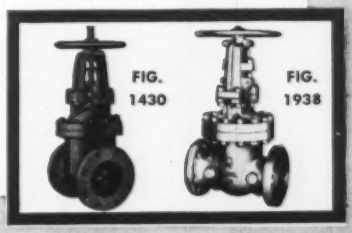
## New Modern IRON and STEEL VALVE PLANT

THIS 400-foot machine bay—one wing of the new Lunkenheimer plant—houses the industry's most up-to-date precision equipment for manufacturing iron and steel valves.

Here, old-world craftsmanship and attention to detail—a Lunkenheimer tradition since 1862—are combined with modern production facilities to assure the highest standards of quality. Lunkenheimer Iron and Steel Valves are world-famous for long life and low maintenance. Their shoulderless seat rings will not warp, and the gates have exclusive machined disc guides that eliminate "chatter" and reduce wear.

This entirely new iron and steel valve plant is located next to the Lunkenheimer bronze plant, which was completely modernized a few years ago in a sweeping $3 million program. Together, they give you the finest, most dependable valves that man can build or money can buy. The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

L-456-29




**STEEL • IRON • BRONZE • PVC**

**LUNKENHEIMER®**

# New Bullard multi-spindle vertical chucking machine combines high precision with high speeds

TO provide lasting precision despite heavy work loads and high speeds, Bullard uses Timken® tapered roller bearings on the lower end of the spindles and on other shafts of its new Mult-Au-Matic Type "L".

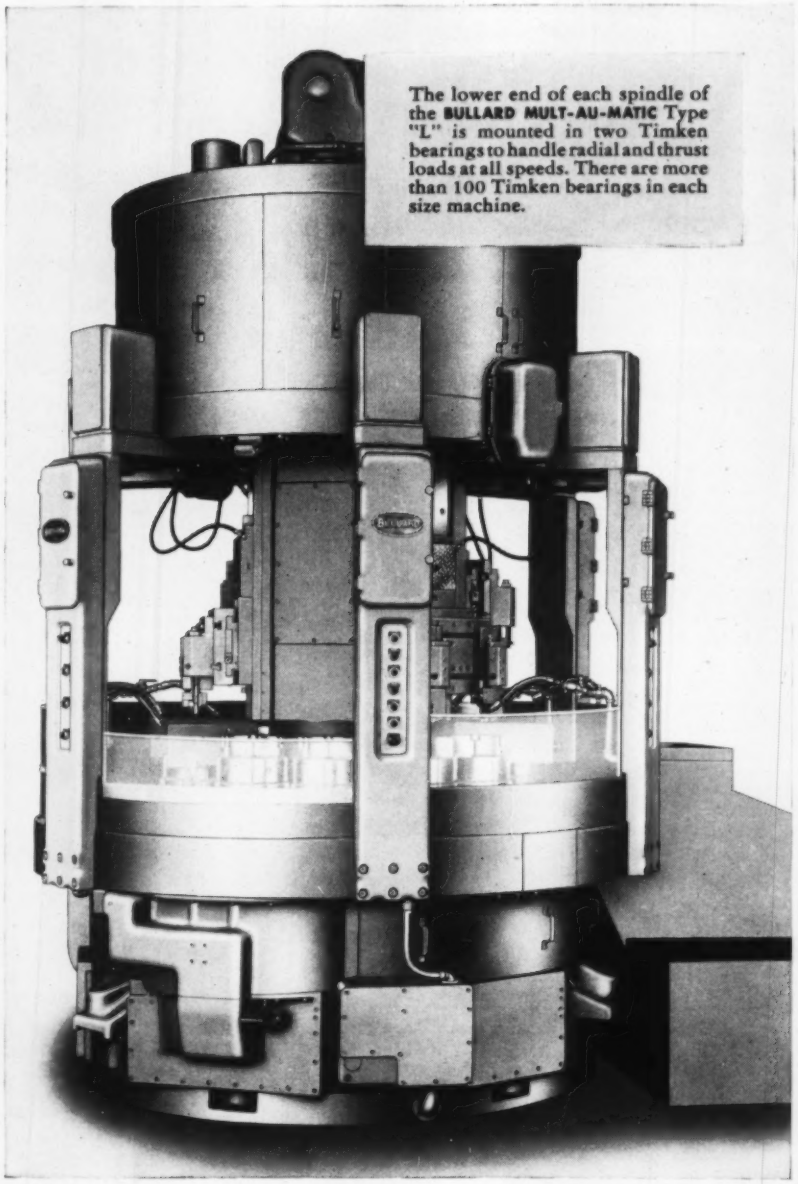
These bearings furnish the precision needed at the locating position at the bottom of each spindle. Full line contact between rollers and races gives Timken bearings extra load-carrying capacity. Their tapered construction takes radial and thrust loads in any combination. Result: shafts are held in rigid alignment; shaft deflection and endplay are minimized; gears mesh smoothly; spindle precision is assured at high speeds.

Timken bearings are geometrically designed for true rolling motion, and precision manufactured to live up to their design.

To insure quality, we even make our own steel. We're America's only bearing manufacturer that does.

So whether you buy or build machine tools, specify Timken bearings. You'll find the trademark "Timken" on every bearing. It's your assurance of high quality. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

*This symbol on a product means its bearings are the best.*



The lower end of each spindle of the **BULLARD MULT-AU-MATIC** Type "L" is mounted in two Timken bearings to handle radial and thrust loads at all speeds. There are more than 100 Timken bearings in each size machine.

## IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

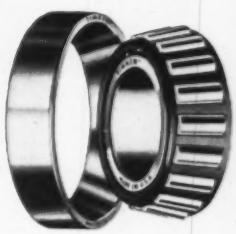
$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

***TAPERED ROLLER BEARINGS***



NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬮ AND THRUST ⬮ LOADS OR ANY COMBINATION ✳